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September 8, 2000

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File No.: SCEI 3.0-030  
Inventor(s): Hiroki OGATA, et al.  
Title : CONTROL APPARATUS AND OUTPUTTING SIGNAL ADJUSTING METHOD THEREFOR

Dear Sir:

Enclosed herewith please find the following documents in the above-identified application for Letters Patent of the United States:

1	Pages of Abstract	Unexecuted Declaration (executed Declaration to follow)
45	Pages of Specification	One (1) return-addressed postcard
17	Number of Claims	<u>PLEASE PROVIDE FILING DATE AND SERIAL NUMBER</u>
45	Sheets of Drawings <input type="checkbox"/> A4 <input checked="" type="checkbox"/> 11"	

Please charge Deposit Account No. 12-1095 in the amount of \$950.00, calculated as follows:

Basic Fee		\$ 690.00
Additional Fees:		
Total number of claims (including multiple dependent claims):	18	
Total number of claims in excess of 20:	0 x \$18	0
Number of independent claims:	2	
Number of independent claims minus 3:	0 x \$78	0
Fee for multiple dependent claim(s) (\$260)		260.00
TOTAL FILING FEE		\$ 950.00

CONVENTION DATE: September 11, 1999 for Japanese Appln. S.N. 11-297205 is claimed.  
Priority Document: ☐ Enclosed ☒ Will follow

In the event the actual fee is greater than the payment authorized above, the Patent Office is authorized to charge any deficiency to our Deposit Account No. 12-1095.

Respectfully submitted,

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## DESCRIPTION

### CONTROL APPARATUS AND OUTPUTTING SIGNAL ADJUSTING METHOD THEREFOR

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#### FIELD OF THE INVENTION

The present invention relates to a control apparatus (controller) which is used for peripheral equipment of entertainment devices such as video game machines.

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#### BACKGROUND OF THE INVENTION

Generally, a variety of control operations of entertainment devices such as video game machines are performed by using control apparatuses. Therefore, a plurality of control buttons are provided on the control apparatuses and the user controls those buttons, thereby controlling the entertainment devices. As an example, the user can control a character which is displayed on a television receiver.

Conventionally, according to the thus-constructed control apparatuses, in many cases, cross-shaped or circular directional control buttons having are disposed at the front-left thereof and a plurality of multi-purpose buttons are disposed at the front-right thereof.

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The directional control buttons and the multi-purpose buttons comprise a tactile switch or rubber switch. Since the switch is turned on/off, the character is moved in a digital manner or the state of the character is changed in a digital manner.

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As explained above, the conventional entertainment device has only a function for digitally changing the character which is displayed on the television receiver by using the directional control buttons or the multi-purpose buttons, and thereby has a disadvantage in that the motion of the character and changes thereof are not gradual and the appearance thereof is poor.

In order to overcome this disadvantage, according to a manipulation device for a game machine disclosed in Japanese Patent Laid-Open (unexamined) No. 7-88252, it is possible to control a character which is displayed on a display screen of a television receiver in an analog manner by adding an analog-type input device which comprises a track ball or joystick, etc. Japanese Patent Laid-Open (unexamined) No. 11-90042 discloses another conventional art to which an analog-type input device is added.

However, the analog-type input device which comprises the track ball or joystick, etc. is quite different from that of the above-described directional control buttons or multi-purpose buttons in view of the operability. Therefore, it is expected that it takes a long time for a user who is accustomed to using the directional control buttons or multi-purpose buttons to become practiced in the operation of the analog-type input device and that the amount of fun which the entertainment device inherently provides is cut by half.

## SUMMARY OF THE INVENTION

In terms of the aforementioned case, it is an object of the present invention to enable operation in an analog manner by pressing operation of a controller of which is normally used for conventional digital operation.

In order to attain the object, according to the present invention, there is provided a control apparatus including a controller which can be pressed and operated, a detecting device for outputting an analog signal corresponding to the pressing operation of the controller, a level segmenting unit for segmenting an output level of the analog signal which is outputted from the detecting device in accordance with the pressing operation of the controller into a plurality of levels, an A/D converting unit for converting the analog signal into a digital signal in accordance with the output levels which are segmented by the level segmenting unit, and a segmenting-range setting unit for setting a range of the output levels of the analog signal which is segmented by the

level segmenting unit, wherein the plurality of levels into which the analog signal outputted by the detecting device is segmented by the level segmenting unit are within the range which is set by the segmenting range-setting unit.

According to the construction of the present invention, the analog signal  
5 corresponding to the pressing control operation of the controller is converted into the digital signal and outputted, thereby realizing a digital control operation by the pressing operation of the controller.

The individual differences of the detecting device and variations in voltage which is applied to the detecting device cause variations in the output levels of the  
10 analog signals which are outputted by the detecting device in accordance with the pressing operation of the controller depending on the control apparatus.

Then, according to the present invention, the control apparatus includes the segmenting-range setting unit for setting a range of the output levels of the analog signal which is segmented by the level segmenting unit, wherein the plurality of levels  
15 into which the analog signal outputted by the detecting device is segmented by the level segmenting unit are within the range which is set by the segmenting-range setting unit.

Accordingly, it is possible to output a digital signal having a plurality of bits which is obtained by uniformly segmenting the levels without influences of the individual differences of the detecting device and variations in voltage which is applied  
20 to the detecting device.

For instance, the segmenting range setting unit can include a storing unit and the level segmenting unit can segment the output level of the analog signal which is outputted by the detecting device into a plurality of levels within the output level range of the analog signal which is stored in the storing unit. According this constitution, as  
25 an example, the controller is pressed and controlled by pressure which is preset and the output level of the analog signal which is outputted by the detecting device is stored in the storing unit, and thereby the output of the digital signal having a plurality of bits

which is obtained by uniformly segmenting the level corresponding to the pressure can be obtained.

A switch for switching the output from the A/D converting unit can select the output having a single bit or a plurality of bits and can obtain the selected output.

5        The segmenting-range setting unit may include a volume device that is inserted in a power line to which the detecting device is connected. The level segmenting unit may segment the range of the output levels of the analog signal outputted by the detecting device into a plurality of levels within a range of output levels which is detected by the volume device (electric-potential setting device). For example, the  
10       combination of a fixed resistance and a variable resistance and a variable resistance, etc. can be applied to the volume device.

As mentioned above, it is possible to set the range of the output levels of the analog signal which is segmented by the level segmenting unit and to segment the levels more properly corresponding to the state of the voltage which is applied to the detecting  
15       device by using the volume device that is inserted in the power line to which the detecting device is connected.

According to the above-constituted control apparatus, in the case of monitoring the output level detected by the volume device which is inserted in the power line to which the detecting device is connected and of changing the output level, if, after  
20       change, a method of segmenting the output level of the analog signal which is outputted by the detecting device into a plurality of levels within the range of the output level which is detected by the volume device is adopted, it is possible to properly correct the range of output levels of the analog signal which is segmented by the level segmenting unit if the voltage state of the power line is changed by the secular change.

25       Further, the segmenting-range setting unit may include a volume device that is inserted in the power line to which the detecting device is connected, a storing unit for storing a limit value of a range of the output levels of the analog signal which is

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The number of parts can be decreased by directly providing the detecting device

Further, the controller is provided with a digital switch and a digital signal generating unit, thereby enabling the digital signal having a single bit and the digital signal having a plurality of bits to be outputted selectively. The digital switch can be constructed by various combination of the detecting device on the structure.

Fig. 1 is a plan view showing the outline of a video game machine which is used with a control apparatus according to embodiments of the present invention;

Fig. 3 is a block diagram showing the main portion of a control apparatus according to a first embodiment of the present invention;

15            Fig. 5 is a block diagram showing an example of the entire configuration of the control apparatus according to the first embodiment of the present invention;

Fig. 7 is a block diagram showing a second structural example for calibration of  
20 the level segmenting unit;

Fig. 9 is a flowchart showing another example of the setting program for calibration which is applied to the second structural example shown in Fig. 7;

Fig. 11 is a diagram for explaining the calibration operation of the third structural

example shown in Fig. 10;

Fig. 12 is a block diagram showing a fourth structural example for calibration of the level segmenting unit;

Fig. 13 is an exploded perspective view showing control buttons (controller)  
5 which are provided in a second control unit according to the first embodiment;

Fig. 14 is an exploded perspective view showing a first structural example of the second control unit according to the first embodiment;

Fig. 15 is a front sectional view showing the first structural example of the second control unit according to the first embodiment;

10 Fig. 16 is an exploded perspective view showing a second structural example of the second control unit according to the first embodiment;

Fig. 17 is a front sectional view showing the second structural example of the second control unit according to the first embodiment;

Fig. 18 is an exploded perspective view showing a third structural example of the  
15 second control unit according to the first embodiment;

Fig. 19 is a front sectional view showing the third structural example of the second control unit according to the first embodiment;

Fig. 20 is an exploded perspective view showing a structural example of a first control unit according to the first embodiment;

20 Fig. 21 is a front sectional view showing the structural example of the first control unit according to the first embodiment;

Fig. 22 is an exploded perspective view showing a structural example of a third control unit according to the first embodiment;

Fig. 23 is a front sectional view showing the structural example of the third  
25 control unit according to the first embodiment;

Fig. 24 is a block diagram showing the main portion in a control apparatus according to a second embodiment of the present invention;

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control unit according to the third embodiment;

Fig. 38 is a diagram for explaining a function of a segmenting-range setting unit for the second control unit according to the third embodiment;

Fig. 39A and Fig. 39B are front sectional views showing a deformed example of a conductive member which forms a part of a detecting device according to the third embodiment of the present invention;

Fig. 40 is a front sectional view showing another structural example of the second control unit according to the third embodiment of the present invention;

Fig. 41 is a front sectional view showing a structural example of a first control unit according to the third embodiment of the present invention;

Fig. 42 is a diagram showing the circuit configuration of a resistor shown in Fig. 41;

Fig. 43 is a diagram showing characteristics of an analog signal which is outputted by an output terminal of the resistor shown in Fig. 42;

Fig. 44 is a block diagram showing the main portion concerning first control unit according to the third embodiment; and

Fig. 45 is a diagram for explaining the function of a segmenting-range setting unit for the first control unit according to the third embodiment.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments according to the present invention will be described in detail hereinbelow with reference to the drawings.

A control apparatus according to the present embodiments is connected to a video game machine as an entertainment device, and can control a character which is displayed on a display screen of a television receiver in a digital/analog manner.

[Outline of the device]

Fig. 1 is a plan view showing the outline of the video game machine with which

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the control apparatus according to the present embodiments is used. As shown in the figure, the video game machine includes a game machine main body 100 which is connected to a television receiver (not shown) which is used as a display and a control apparatus 200 which is connected to the game machine main body 100.

5       The game machine main body 100 is provided therein with a disk-drive unit 101 for reading an optical disk on which a game program is recorded, an image processing device for displaying characters and a background picture on the screen of the television receiver in accordance with the game program which is stored in the optical disk, and the like. The game machine main body 100 is also provided therein with a reset switch  
10   102 for resetting the game during execution, a power switch 103, and a casing opening control button 105 for controlling an operation for opening/closing a casing 104 which opens/closes a disk loading unit of the disk-drive unit 101.

      The control apparatus 200 is connected to the game machine main body 100 via a connecting cord 202 which is led out from a device main body 201. A connector 203  
15   is provided at one end of the connecting cord 202. The connector 203 is connected to a jack 106 which is provided in one side of the game machine main body 100, thereby connecting the control apparatus 200 to the game machine main body 100.

      Fig. 2 is a plan view showing the control apparatus. A first control unit 210 and a second control unit 220 are provided on the upper side of the device main body 201 of  
20   the control apparatus 200, and a third control unit 230 and a fourth control unit 240 are provided on the lateral side thereof.

      The first control unit 210 comprises one cross-shaped control body 211 for pressing control operation, and control keys 211a which extend in four directions form the control body 211. The first control unit 210 causes a character displayed on the  
25   screen of the television receiver to be moved and has a function for moving the character vertically and horizontally by pressing the control keys 211a in the control body 211.

The second control unit 220 comprises four columnar-shaped control buttons (controller) 221 for pressing control operation. Identification marks such as a circle "o", triangle "Δ", square, "□" and cross "x" are provided on the control buttons 221, so that it is easy to identify the individual control buttons 221. The function of the second control unit 220 is determined by the game program which is recorded in the optical disk. A function for changing the state of a game character is assigned to the control buttons 221. For example, functions for moving the right and left arms and the right and left legs are assigned.

The third and fourth control units 230 and 240 have almost the same structure, and comprise two control buttons 231 (controller) and two control buttons (controller) 241, respectively. The functions of the third and fourth control units 230 and 240 are determined by the game program which is recorded in the optical disk, for example, functions for performing special movements of the game character are assigned.

Further, joysticks 251 for analog operation are provided in the device main body 201 shown in Fig. 2. The joysticks 251 switch the first and second control units 210 and 220, thereby making the device more usable. The switching operation is performed by an analog-selecting switch 252 which is provided in the device main body 201. When the joysticks 251 are selected, a display unit 253 which is provided in the device main body 201 is lit, thereby indicating that the joysticks 251 are selected.

Incidentally, the device main body 201 also has a start switch 254 for instructing starting of the game and a select switch 255 for selecting the degree of difficulty of the game when starting the game.

#### [First embodiment]

The following is a next detailed description of the structure of a first embodiment of the present invention.

Fig. 3 is a block diagram showing the main portion of a control apparatus

according to the first embodiment of the present invention.

The control units 210, 220, 230, and 240 for pressing control operation in the control apparatus 200 have a controller 11 comprising the control keys 211a of the control body 211 and the control buttons 221, 231, and 241, and a pressure-sensitive  
5 device (detecting device) 12.

The pressure-sensitive device 12 is made of pressure-sensitive conductive rubber, and electrodes 12a and 12b are formed at two ends thereof which are positioned symmetrically. One electrode 12a is connected to a power line 13 and a predetermined voltage is applied thereto from a power source (Vcc). The resistance between the  
10 electrodes 12a and 12b changes in accordance with the magnitude of a pressure which acts on the pressure-sensitive device 12.

As one example, the pressure-sensitive device 12 made of pressure-sensitive conductive rubber exhibits the smallest resistance when no pressure acts, and the resistance increases as the applied pressure becomes larger, as shown by a dotted line in  
15 Fig. 4. Therefore, the largest analog signal (voltage) is outputted at the other electrode 12b when no pressure acts, and the analog signal (voltage) which is outputted decreases as the pressure increases (solid line in Fig. 4).

The pressure-sensitive device 12 is disposed in the path/line into which the controller 11 is pushed. As the user presses the controller 11, pressure is applied and the  
20 resistance of the pressure-sensitive device 12 changes. The analog signal corresponding to the pressure is outputted at the electrode 12b side.

A microprocessor unit 14 (abbreviated to MPU, hereinafter) for controlling the control apparatus 200 is mounted on an internal board of the control apparatus 200. The MPU 14 functions as a level segmenting unit (LS) 15 for segmenting the output level of  
25 the analog signal which is outputted by the pressure-sensitive device 12 into a plurality of levels, an A/D converting unit 16 for converting the analog signal which is outputted from the pressure-sensitive device 12 into a digital signal in accordance with the output

level which is segmented by the level segmenting unit 15, and a switch 18 which will be explained hereinafter. The electrode 12b of the pressure-sensitive device 12 is connected to an input side of the level segmenting unit 15.

The level segmenting unit 15 has a fundamental function for segmenting the  
5 range of a preset analog signal level (voltage) by a uniform width, as shown in Fig. 4. The number of segments can be set arbitrarily, and the example shown in Fig. 4 illustrates that the range of analog signal level (voltage) is uniformly segmented into eight levels. Individual output levels L1 to L8 which are thus uniformly segmented are transmitted to the A/D converting unit 16. Incidentally, the range of the analog signal  
10 level which is uniformly segmented by the level segmenting unit 15 can be arbitrarily changed.

The A/D converting unit 16 converts the analog signal which is segmented into levels by the level segmenting unit 15 into a digital signal in accordance with the output level of the analog signal and outputs the digital signal. That is, digital signals having a  
15 plurality of bits are outputted by the A/D converting unit 16 in accordance with the output level L1 to L8.

Herein, a description will be given of a specific example of the level segmenting unit 15 and the A/D converting unit 16. If it is assumed that the control apparatus 200 is driven by a power supply voltage of 3.5 V, the analog signal which is outputted by the  
20 pressure-sensitive device 12 changes from 0 to 2.4 V. If it is also assumed that the level segmenting unit 15 uniformly segments the output level ranging from 0 to 2.4 V into eight levels, one level has a level width of 0.3 V.

Therefore, the level segmenting unit 15 segments the output levels of 2.4 to 2.1 V, 2.1 to 1.8 V, 1.8 to 1.5 V, 1.5 to 1.2 V, 1.2 to 0.9 V, 0.9 to 0.6 V, 0.6 to 0.3 V, and 0.3 to  
25 0 V of the analog signal which is outputted by the pressure-sensitive device 12 into level 1 (L1), level 2 (L2), level 3 (L3), level 4 (L4), level 5 (L5), level 6 (L6), level 7 (L7), and level 8 (L8), respectively.

The A/D converting unit 16 assigns proper digital signals having a plurality of bits to the output levels which are level-segmented as disclosed above and outputs the digital signals. For instance, digital signals having a plurality of bits, e.g., 8 bits or 16 bits, are assigned to the output levels, and digital signals of "1f", "3f", ..., "ff" (hexadecimal notation) are assigned to level 1, level 2, ..., level 8, respectively, and are outputted.

The digital signal which has a plurality of bits and is outputted by the A/D converting unit 16 is transmitted to the game machine main body 100 via an interface 17 which is provided in the internal board of the control apparatus 200, so that the digital signal causes the game character to be moved, etc.

The change in level of the analog signal outputted by the pressure-sensitive device 12 corresponds to the change in pressure applied by the controller 11 applied, as mentioned above. Accordingly, the digital signal which has a plurality of bits and is outputted by the A/D converting unit 16 corresponds to the pressure on the controller 11 by the user. If the operations for the game character, etc. are controlled in response to the digital signal having a plurality of bits which is related to the user's pressing operation, it is possible to realize a smoother operation in an analog manner, as compared with the ON/OFF control operation in response to a single-bit digital signal which is "1" or "0".

According to the present embodiment, the A/D converting unit 16 also functions as an output unit which outputs a single-bit digital signal having a single bit (i.e., "1" or "0") in accordance with the change in analog signal outputted by the pressure-sensitive device 12 and in response to the switching operation of the switch 18. Either the digital signal having a plurality of bits or the digital signal having a single bit is outputted by the A/D converting unit 16.

According to the present embodiment, the switch 18 is controlled in response to a control signal which is sent from the game machine main body 100 on the basis of the

game program recorded in the optical disk. That is, if the game program which is recorded in the optical disk is executed, the game machine main body 100 outputs the control signal for instructing the A/D converting unit 16 to function as an output unit for digital signal having a plurality of bits or outputs the control signal for instructing the A/D converting unit 16 to function as an output unit for the digital signal having a single bit in accordance with the contents of the game program. Based on the control signal, the switch 18 selects and switches the function of the A/D converting unit 16.

According to the function which is selected by the switch 18, the A/D converting unit 16 converts the analog signal outputted by the pressure-sensitive device 12 into the digital signal having a plurality of bits or the digital signal having a single bit and outputs the converted digital signal. If the function as the output unit for the digital signal having a plurality of bits is selected, the output level which is uniformly segmented by the level segmenting unit 15 as mentioned above is converted into the corresponding digital signal and is outputted to the game machine main body 100. On the other hand, if the function as the output unit for the digital signal having a single bit is selected, the digital signal having a single bit "1" or "0" is outputted to the game machine main body 100 in accordance with the change in the analog signal outputted by the pressure-sensitive device 12.

The switch 18 may be switched by the user's manual operation. For instance, a function for switching the switch 18 is allocated to the analog-selecting switch 252 provided in the control apparatus 200 and the switch 18 is operated by the manual operation of the analog-selecting switch 252, thereby switching the function of the A/D converting unit 16.

According to the present embodiment, as shown in Fig. 5, the first to fourth control units 210, 220, 230, and 240 have the configuration shown in Fig. 3. Thus, it is possible to separately use digital operation and the analog operation of the control units 210, 220, 230, and 240. Incidentally, only the control unit which is arbitrarily selected



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Assuming that a default value of the level segmenting unit 15 is set so as to uniformly segment the voltage level ranging from 0 to 2.4 V into eight levels and an analog signal of 2.0 V is outputted by the pressure-sensitive device 12 when the predetermined load acts, the A/D converting unit 16 outputs the digital signal "3f" which corresponds to level 2, as explained above. The digital signal "3f" is stored in the memory 20, and the level segmenting unit 15 adjusts the output range of the analog signal which is level-segmented on the basis of the set value.

Incidentally, the digital signal "3f" corresponds to the output level of the analog signal of 2.1 V to 1.8 V. Preferably the voltage value within the range is specified in advance. For instance, it is specified in advance that a maximum voltage value (2.1 V in the foregoing example) of the output levels is the upper limit of the range of output levels of the analog signal which is segmented into the levels.

Fig. 7 is a block diagram showing a second structural example for calibration of the level segmenting unit. According to the configuration shown in the figure, a memory is not provided in the control apparatus 200 and, in place thereof, the range of output levels of the analog signal which is segmented by the level segmenting unit 15 is stored in a built-in memory 111 of the game machine main body 100 to which the control apparatus 200 is connected or into a memory card 112 which is detachable.

When the calibration of the level segmenting unit 15 is executed by using this configuration, preferably, a setting program for executing the calibration operation is built in a control program which is stored in a ROM 110 in the game machine main body 100.

Fig. 8 is a flowchart showing one example of the setting program.

First of all, a power supply of the game machine main body 100 is turned on (step S1). The sensitivity setting (calibration) of the control unit is selected by the menu selection by the user (step S2). Then, a setting screen is displayed on the television receiver 120 (step S3). For example, a message for prompting the user to strongly press

the controller 11 which is provided in the predetermined control unit is displayed on the setting screen. When the user presses the controller 11 strongly according to the display, the output level of the analog signal from the pressure-sensitive device 12 which is detected in this case is outputted to the game machine main body 100 (step S4). The output level is stored in the built-in memory 111 (step S5). The above-mentioned steps are repeated for the level segmenting unit 15 in the control apparatus 200 (step S6), and the sensitivity setting of the control unit ends.

The level segmenting unit 15 provided in the control apparatus 200 adjusts the range of output levels of the segmented analog-signal on the basis of the set value which is stored in the built-in memory 111 in the game machine main body 100.

It is also possible to provide the setting program for executing the calibration operation in the game program which is recorded in the optical disk.

Fig. 9 is a flowchart showing another example of the setting program.

To start with, the optical disk is loaded in the game machine main body 100 (step S10). Thereafter, it is checked to see if the memory card 112 is loaded in the game machine main body 100 (step S11). If the memory card 112 is not loaded, the user's menu-selection causes the selection of the sensitivity setting (calibration) of the control unit (step S12), and the setting screen is displayed on the television receiver 120 (step S13). For instance, a message for prompting the user to strongly press the controller 11 which is provided in the predetermined control unit is displayed on the setting screen. When the user strongly presses the controller 11 according to the display, the output level of the analog signal from the pressure-sensitive device 12 which is detected in this case is outputted to the game machine main body 100 (step S14). The output level is stored in the built-in memory 111 (step S15). The above-mentioned steps are repeated for the level segmenting unit 15 in the control apparatus 200 (step S16), and the sensitivity setting of the control unit ends.

If it is detected in step S11 that the memory card 112 is loaded, it is checked to

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value. The comparator 23 always monitors the intermediate voltages V1 and V2 which are detected by the volume devices 21 and 22, and a function for comparing the limit value which is stored in the memory 24 with the intermediate voltages V1 and V2 (especially, V1) and forcedly sending the limit value to the level segmenting unit 15  
 5 when the intermediate voltage is over the limit value is provided. If the limit value is sent from the comparator 23, the range of output levels of the analog signal which is segmented on the basis of the limit value is adjusted.

According to the above-described constitution, if an analog signal of an excessive output level, which is above the processing capacity of the MPU 14, is  
 10 outputted by the pressure-sensitive device 12, the normal operation of the MPU 14 can be compensated.

Next, a detailed description is given of a structural example of the control unit which is provided in the control apparatus 200 according to the first embodiment of the present invention.

15 Fig. 13 to Fig. 15 are diagrams showing a first structural example of the second control unit.

The second control unit 220 comprises the four control buttons 221 constructing the controller 11, an elastic body 222, and a sheet member 223 in which the pressure-sensitive devices 12 are provided, as shown in Fig. 14. As shown in Fig. 13, the control  
 20 buttons 221 are mounted, from the back side thereof, to mounting holes 201a which are formed in the upper surface of the device main body 201. The control buttons 221 mounted in the mounting holes 201a are movable in the axial direction.

The elastic body 222 is made of insulative rubber, etc., has elastic portions 222a which are projected upward, and supports the lower ends of the control buttons 221 at  
 25 the upper surfaces of the elastic portions 222a. If the control buttons 222 are depressed, sloping portions of the elastic portions 222a are bent and the upper surfaces of the elastic portions 222a move together with the control buttons 221. If the pressures to the



the control button 221 by the flat surface thereof. If this construction is used, although the sensitivity with which the pressure from the control buttons 221 is transmitted to the pressure-sensitive device 12 is decreased, the advantage of improved durability of the pressure-sensitive devices 12 and the elastic body 222 is obtained.

5        Fig. 18 and Fig. 19 are diagrams showing a third structural example of the second control unit.

According to the third structural example shown in the figures, the pressure-sensitive devices 12 are directly provided at proper portions on an internal board 204 which is built in the control apparatus 200. By providing the pressure-sensitive devices  
10    12 on the internal board 204, the sheet member can be omitted and the number of parts can be reduced. Incidentally, of course, the pressure-sensitive devices 12 are provided at portions to which the pressure from the control buttons 221 is transmitted.

Fig. 20 and Fig. 21 are diagrams showing a structural example of the first control unit.

15        As shown in Fig. 20, the first control unit 210 comprises the cross-shaped control body 211, a spacer 212 for positioning the control body 211, and an elastic body 213 for elastically supporting the control body 211 and, further, as shown in Fig. 21, has a configuration in which the pressure-sensitive devices 12 are arranged at positions which face the control keys 211a (controller 11) of the control body 211 via the elastic body  
20    213.

The overall/general structure of the first control unit 210 is well known from Japanese Patent Laid-Open (unexamined) No. 8-163672, etc., and thus a detailed description is omitted. However, the control body 211 is assembled so as to enable the control keys 211a (the controller) to be pressed to the sides of the pressure-sensitive  
25    devices 12 (Fig. 21) while a convex portion 212a having hemispheric shapes which is formed at the center of the spacer 212 is set at the fulcrum.

If the control key 211a serving as the controller 11 is pressed, the pressure acts



on the pressure-sensitive device 12 via the elastic body 213 and the resistance of the pressure-sensitive device 12 is changed in accordance with the magnitude of the pressure. The structural example shown in Fig. 21 illustrates that the pressure-sensitive devices 12 are directly provided at proper portions on the internal board 204 which is built in the control apparatus 200. However, similarly to the structural example of the second control unit 220 shown in Figs. 14 and 15, the pressure-sensitive devices 12 can be provided on the sheet member 23.

Fig. 22 and Fig. 23 are diagrams showing a structural example of the third control unit.

The third control unit 230 comprises the two control buttons 231, a spacer 232 for positioning the control buttons 231 in the control apparatus 200, a holder 233 for supporting the control buttons 231, an elastic body 234, and an internal board 235, and has the pressure-sensitive devices 12 to proper portions on the internal board 235.

The overall/general structure of the third control unit 230 is also well-known from Japanese Unexamined Patent Laid-Open (unexamined) No. 8-163672, etc., and thus a detailed description is omitted. However, the control buttons 231 can be pressed while being guided by the spacer 232. The pressure when the control buttons 231 are pressed acts on the pressure-sensitive devices 12 via the elastic body 234. The resistance of the pressure-sensitive devices 12 is changed in accordance with the magnitude of the applied pressure. The structural example shown in Figs. 22 and 23 illustrate that the pressure-sensitive devices 12 are directly provided at proper portions of the internal board 235 which is built in the control apparatus 200. However, similarly to the structural example of the second control unit 220 shown in Fig. 14 and Fig. 15, the pressure-sensitive device 12 can also be provided on the sheet member 223.

Incidentally, the fourth control unit 240 is also constructed similarly to the third control unit 230.

Although the above description shows the structural examples in the case in

which the present invention is applied to the first to fourth control units 210, 220, 230, and 240, the present invention is not limited to be applied to all of the control units. The control unit to which the present invention is applied can be selected arbitrarily and the other control units can have conventional constructions.

5

**[Second embodiment]**

Next, a detailed description is given of constitution of a second embodiment of the present invention. Incidentally, the same reference numerals denote the same portion as those of the first embodiment which have already been described, and thus a  
10 detailed description thereof is omitted.

The control apparatus 200 according to the first embodiment generates both a digital signal having a plurality of bits and a digital signal having a single bit on the basis of the analog signal which is outputted by the pressure device 12. However, according to the second embodiment, as will be described hereinbelow, a digital signal  
15 having a plurality of bits is generated from the analog signal outputted by the pressure-sensitive device 12 and, a digital signal having a single bit is outputted by detecting the on/off state of a digital switch.

Fig. 24 is a block diagram showing the main portion of a control apparatus according to the second embodiment.

20 According to the present embodiment, the control units 210, 220, 230, and 240 in the control apparatus 200 have the controller 11 comprising the control buttons 221, 231 and 241 and the control keys 211a of the control body 211; the pressure-sensitive device 12 (detecting device); and a digital switch 30. Among them, the controller 11 and pressure-sensitive device 12 have a similar construction to those in the control apparatus  
25 200 according to the above-mentioned first embodiment.

The digital switch 30 comprises first and second fixed-terminals 31 and 32 and a movable member 33 which is connected/disconnected to the fixed terminal 31 and 32

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and whereby the fixed terminals are connected or disconnected. The movable member 33 moves in accordance with the pressing operation of the controller 11 and connects or disconnects the first and second fixed terminals 31 and 32. As shown in Fig. 24, the first fixed terminal 31 of the digital switch 30 is connected to the power line 13, thereby  
5 applying a predetermined voltage thereto from the power source (Vcc).

The MPU 14 provided on the internal board of the control apparatus 200 comprises a digital-signal generating unit 35 for detecting the on/off state of the digital switch 30 and outputting a digital signal having a single bit, a change-over switch 18a for switching the output from the digital-signal generating unit 35 and the output from  
10 the A/D converting unit 16 and outputting the signal to the outside, the switch 18 for operating the change-over switch 18a, the level segmenting unit (LS) 15, and of the A/D converting unit 16.

The A/D converting unit 16 according to the present embodiment has only the function of converting the analog signal outputted by the pressure-sensitive device 12  
15 into a digital signal having a plurality of bits and outputting the converted digital signal.

The input terminal of the digital-signal generating unit 35 is connected to the second fixed terminal 32 of the digital switch 30, thereby monitoring a voltage change which is caused at the second fixed terminal 32. In other words, if the digital switch 30 is turned on, the second fixed terminal 32 has the same potential as that of the power  
20 line 13. If the digital switch 30 is turned off, the second fixed switch 32 is set to 0 V. The digital-signal generating unit 35 outputs the digital signal having a single bit ("0" or "1") in accordance with the voltage change which is caused at the second fixed terminal 32.

According to the present embodiment, the switch 18 is also controlled in  
25 response to the control signal which is sent by the game machine main body 100 on the basis of the game program that is recorded in the optical disk. That is, if the game program which is loaded in the optical disk is executed, the game machine main body

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100 outputs the control signal to connect the change-over switch 18a to the A/D converting unit 16 side or to connect the change-over switch 18a to the digital-signal generating unit 35. Based on the control signal, the switch 18 operates the change-over switch 18a.

5        The change-over switch 18a may also be switched by the user's manual operation. For instance, a function for switching the switch 18 can be allocated to the analog-selecting switch 252 which is provided in the control apparatus 200, and the change-over switch 18a can be operated by the manual operation of the analog-selecting switch 252.

10        According to the control device 200 of the second embodiment having the above-mentioned construction, the movable member 33 of the digital switch 30 connects the first and second fixed terminals 31 and 32 in accordance with the pressing operation of the controller 11 and the analog signal is outputted by the pressure-sensitive device 12 in accordance with the pressure which is applied by the controller 11.  
15        The digital-signal generating unit 35 outputs the digital signal having a single bit in accordance with the change in state of the digital switch 30, and the A/D converting unit 16 outputs the digital signal having a plurality of bits which has the output level in accordance with the pressure applied to the pressure-sensitive device 12.

20        Therefore, the selection by the change-over switch 18a causes the control apparatus 200 to output either the digital signal having the single bit or the digital signal having the plurality of bits to the game machine main body 100.

25        According to the present embodiment, as shown in Fig. 25, the first to fourth control units 210, 220, 230, and 240 have the construction shown in Fig. 24. Thus, it is possible for each of the control units to separately use digital operation or analog operation. Incidentally, as shown in Fig. 26, it is also possible for only the control unit which is arbitrarily selected from among the first to fourth control units 210, 220, 230, and 240 to have the construction shown in Fig. 24.

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The control apparatus 200 according to the present embodiment also has the calibration function (segmenting-range adjusting unit) for individually setting the range of output levels of the analog signal which is to be segmented by the level segmenting unit 15, as shown in Figs. 6, 7, 10, and 12.

5        Next, a detailed description is given of structural examples of the second control unit which is provided in the control apparatus 200 according to the second embodiment of the present invention with reference to the drawings.

Fig. 27 and Fig. 28 are diagrams showing a first structural example according to the present embodiment.

10        The second control unit 220 comprises, four control buttons 221 serving as the controller 11, an elastic body 222, a sheet member 224 on which the pressure-sensitive devices 12 are provided, and a sheet member 225 on which the first and second fixed terminals 31 and 32 of the digital switch 30 are provided, as shown in Fig. 27. The control buttons 221 are mounted in mounting holes 201a which are formed in the upper  
15        surface of the device main body 201 from the back side, similarly to the aforementioned case in the first embodiment (refer to Fig. 13). The control buttons 221 which are mounted in the mounting holes 201a can be moved in the axial direction.

The elastic body 222 is made of insulative rubber, etc., has elastic portions 222a which project upward, and supports the lower ends of the control buttons 221 at the  
20        upper surfaces of the elastic portions 222a. If the control buttons 221 are depressed, sloping portions of the elastic portions 222a are bent and the upper surfaces of the elastic portions 222a are moved together with the control buttons 221. If the pressures to the control buttons 221 are removed, the sloping portions of the elastic portions 222a which are bent are elastically restored, and the control buttons 221 are pushed up. That  
25        is, the elastic body 222 functions as energizing means for restoring the control buttons 221, which are depressed by the pressing operation, to the original positions.

The movable member 33 of the digital member 30 is formed at the inside of the

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ceiling surface of the upper surfaces of the elastic portions 222a (refer to Fig. 28). The movable member 33 is made of a conductive material and moves down by deformation of the elastic portions 222a due to bending according to the pressing operation of the control buttons 221.

5        The sheet member 225 is made of a thin-sheet material such as a flexible and insulative membrane. The first and second fixed terminals 31 and 32 are provided at proper portions of the sheet member 225. As shown in Fig. 28, the first and second fixed terminals 31 and 32 are arranged so as to face the movable member 33. According to the structure, the movable member 33 formed below the upper surfaces of  
10    the elastic portions 222a is moved in accordance with the pressing operation of the control buttons 221 serving as the controller 11 and makes contact with the first and second fixed terminals 31 and 32, thereby electrically connecting the fixed terminals 31 and 32.

      The sheet member 224 is also made of an insulative thin-sheet material. The  
15    pressure-sensitive devices 12 are provided at proper portions of the sheet member 224. As shown in Fig. 28, the pressure-sensitive devices 12 are arranged so as to face the control buttons 221 via the elastic body 222 and the sheet member 225.

      As explained above, the shape of the sheet member 225 is flexible and thin, so that it is capable of transmitting the pressure on the control buttons 221 transmitted  
20    through the upper walls of the elastic portions 222a and the movable member 33 to the pressure-sensitive devices 12 substantially unchanged.

      Fig. 29 and Fig. 30 are diagrams showing a second structural example of the second control unit according to the present embodiment.

      According to the second structural example shown in the figures, the pressure-  
25    sensitive devices 12 are directly provided at proper portions of the internal board 204 which is built in the control apparatus 200. As a result of directly providing the pressure-sensitive devices 12 on the internal board 204, it is possible to omit the sheet

member 224, and to decrease the number of parts. Then, of course, the pressure-sensitive devices 12 are provided at positions to which the pressure from the control buttons 221 is transmitted.

5 Figs. 31A, 31B, and 32 are diagrams showing a third structural example of the second control unit according to the present embodiment.

According to the third structural example shown in the figures, the first and second fixed terminals 31 and 32 of the digital switch 30 are provided on the surface of the sheet member 225, and the pressure-sensitive device 12 is provided at the back side of the sheet member 225. The first and second fixed terminals 31 and 32 and the  
10 pressure-sensitive devices 12 are positioned so as to face each other by sandwiching the sheet member 225. The sheet member 225 is disposed so that the pressure-sensitive devices 12 are supported in a flat manner by the internal wall 200a of the control apparatus 200 and a wired circuit (refer to Fig. 32).

The above-described structure enables the omission of one sheet member.

15 Fig. 33 is a diagram showing a fourth structural example of the second control unit according to the present embodiment.

According to the fourth structural example shown in the figure, the movable member 33 of the digital switch 30 is set at the back side of the sheet member 224 on which the pressure-sensitive device 12 is provided. The arrangement of the sheet  
20 member 224 and the sheet member 225 is changed and the sheet member 224 is disposed at the intermediate portion between the sheet member 225, to which the first and second fixed terminals 31 and 32 are provided, and the elastic body 222. The sheet member 225 is disposed so as to be supported in a flat manner by the internal wall 200a of the control apparatus 200 and a wired circuit (refer to Fig. 33).

25 According to the present embodiment, although the various examples of the second control unit 220 are described, the other control units 210, 230, and 240 can be constructed similarly thereto.

Moreover, the first and second embodiments are described by use of the pressure-sensitive device 12 having the characteristics shown in Fig. 4 and Fig. 11. In other words, according to the characteristics, an increase in the pressure to the controller 11 causes the resistance of the pressure-sensitive device 12 to increase and the output voltage to decrease. However, according to the first and second embodiments, it also possible to use a pressure-sensitive device 12 having characteristics which are opposite to the aforementioned ones. That is, according to the opposite characteristics, an increase in the pressure to the controller 11 causes the resistance of the pressure-sensitive device 12 to decrease and the output voltage to increase. By using the pressure-sensitive device 12 having the opposite characteristics, the input characteristics of the level segmenting unit 15 need to be inverted. However, the pressure-sensitive device 12 has characteristics such that a large voltage is not applied unless the controller 11 is pressed.

#### 15 [Third embodiment]

Next, a detailed description is given of the structure according to a third embodiment of the present invention. Incidentally, the same reference numerals denote the same portions as those of the first embodiment which has already been described, and thus a detailed description thereof is omitted.

20 Although the control apparatus 200 according to the first embodiment utilizes the pressure-sensitive device 12 as a detecting device, a detecting device according to the third embodiment, which will be described, comprises a resistor 40 and a conductive member 50.

25 Fig. 34A to Fig. 34C are diagrams showing one structural example of a second control according to the present embodiment. Although only a single control button 221 and the related structure are shown in the figures, a plurality of the control buttons 221 can be provided in the second control unit 220, each having the same structure as



the structure shown in the figures if any desired control button 221 is selected.

In other words, the second control unit 220 according to the present embodiment comprises the control button 221 serving as the controller 11, the elastic body 222, the conductive member 50, and the resistor 40. The conductive member 50 is made of, e.g.,  
 5 conductive rubber having elasticity, and is formed with a peak shape in which the top of the peak is at the center. The conductive member 50 is adhered to the inside of the ceiling surface of the elastic portion 222a which is formed in the elastic body 222.

The resistor 40 is provided, for instance, on the internal board 204 so as to face the conductive member 50, and the conductive member 50 makes contact with the  
 10 resistor 40 in accordance with the pressing operation of the control button 221. The conductive member 50 is deformed in accordance with the pressure on the control button 221 (that is, contact pressure with the resistor 40), thereby changing the contact area with the resistor 40, as shown in Figs. 34B and 34C. In other words, when the pressure on the control button 221 is small, the portion near the top of the conductive  
 15 member 50 having a peak shape makes contact with the resistor 40, as shown in Fig. 34B. Further, when the pressure on the control button 221 becomes larger, the conductive member 50 is gradually deformed from the top thereof and the contact area becomes larger.

Fig. 35 is a diagram showing a circuit construction of the resistor 40, the  
 20 conductive member 50, and devices peripheral thereto. A variable resistor 42 corresponds to the combination of the conductive member 50 and the resistor 40 in Figs. 34A to 34C. A fixed resistor 41 (not shown in Figs. 34A to 34C) is connected to the resistor 40. A power supply voltage  $V_{cc}$  is applied to the variable resistor 42 and the fixed resistor 41 which are serially connected, that is, across electrodes 40a and 40b.

25 The variable resistor 42 corresponds to the combination of the conductive member 50 and the resistor 40. The resistance of the variable resistor 42 changes in accordance with the contact area between the conductive member 50 and the resistor 40.

That is, if the conductive member 50 makes contact with the resistor 40, the conductive member 50 functions as a bypass for the resistor 40 and a current flows. Therefore, the contact portion is effectively short-circuited, so that the resistance of the resistor 40 drops. As the contact area of the conductive member 50 becomes larger, the resistance  
5 of the resistor 40 is decreased more.

The power supply voltage  $V_{cc}$  applied across the electrodes 40a and 40b is divided by the variable resistor 42 whose resistance changes in accordance with the pressure on the control button 221 and the fixed resistor 41. Thus, the output voltage which is obtained from an output terminal 40c between the variable resistor 42 and the  
10 fixed resistor 41 becomes larger as the resistance of the variable resistance 42 becomes smaller and, on the other hand, the output voltage becomes smaller as the resistance of the variable resistance 42 becomes larger.

Fig. 36 is a diagram showing the characteristics of the analog signal (voltage) which is outputted from the output terminal 40c of the resistor 40.

15 To start with, since a voltage is applied to the resistor 40 when the power is turned on, a predetermined analog signal (voltage)  $V_{min}$  is outputted from the output terminal 40c until the control button 221 is pressed (a position "a" shown in the figure). Subsequently, since the resistance of the resistor 40 is not changed until the conductive member 50 makes contact with the resistor 40 when the control button 221 is pressed,  
20 the output from the resistor 40 is held at  $V_{min}$  and is not changed. Further, the control button 221 is pressed and the conductive member 50 makes contact with the resistor 40 (a pressing position "b" in the figure) and, thereafter, the contact area of the conductive member 50 with the resistor 40 increases in accordance with the pressure on the control button 221. Thus, the internal resistance of the resistor 40 decreases and the analog  
25 signal (voltage) which is outputted from the output terminal 40c of the resistor 40 increases. When the conductive member 50 is deformed to the greatest extent, the analog signal (voltage) outputted from the output terminal 40c of the resistor 40 is equal

to a maximum value  $V_{max}$  (a pressed position "c" in the figure).

Fig. 37 is a block diagram showing the main portion of the control apparatus according to the third embodiment of the present invention.

According to the present embodiment, the MPU 14 provided on the internal  
5 board of the control apparatus 200 also comprises the level segmenting unit 15, the A/D  
converting unit 16, and the switch 18. According to the present embodiment, the analog  
signal (voltage) which is outputted from the output terminal 40c of the resistor 40 is  
inputted to the level segmenting unit 15, then, the output level of the analog signal is  
segmented into a plurality of levels by the level segmenting unit 15, and, further, the  
10 A/D converting unit 16 converts the analog signal which is outputted by the resistor 40  
into a digital signal in accordance with the segmented output level.

The functions of the level segmenting unit 15 and A/D converting unit 16 are the  
same as those of the aforementioned first embodiment. The level segmenting unit 15  
has a fundamental function for segmenting the range of levels of the analog signal  
15 (voltage) which is outputted from the resistor 40 by a uniform width, as shown in Fig.  
36. The number of segments can be arbitrarily set and, in the example shown in Fig. 36,  
the range of levels of the analog signal (voltage) is uniformly segmented into eight  
levels. The individual output levels L1 to L8 which are segmented uniformly as  
discussed above are transmitted to the A/D converting unit 16. Incidentally, the range  
20 of levels of the analog signal which is uniformly segmented by the level segmenting  
unit 15 can be changed arbitrarily.

The A/D converting unit 16 converts the analog signal level-segmented by the  
level segmenting unit 15 into the digital signal in accordance with the output level of the  
analog signal and outputs the digital signal. In other words, the A/D converting unit 16  
25 outputs the digital signal having a plurality of bits in accordance with the output levels  
L1 to L8.

The A/D converting unit 16 assigns the digital signal having a proper plurality of

bits to the output level which is level-segmented, and outputs the digital signal. As an example, the digital signal having a plurality of bits, e.g., 8 bits or 16 bits, is assigned to the output level and the digital signals "1f", "3f", ..., "ff" are assigned and outputted in the cases of level 1 (L1), level 2 (L2), ..., level 8 (L8), respectively.

- 5        The digital signal having a plurality of bits which is outputted by the A/D converting unit 16 is transmitted to the game machine main body 100 by way of the interface 17 that is provided to the internal board of the control apparatus 200. The digital signal causes the movement of the game character, etc.

- 10        The level change in the analog signal which is outputted from the output terminal 40c of the resistor 40 corresponds to the change in the pressure which is applied by the control button 221 (controller 11). Therefore, the digital signal having the plurality of bits which is outputted by the A/D converting unit 16 corresponds to the pressure on the control button 221 (controller 11) by the user. If the operation of the game character, etc. is controlled by the digital signal having the plurality of bits which has the above-  
15        explained relation with the user's pressing operation, it is possible to realize a smoother operation in an analog manner as compared with the control operation by the digital signal having a single bit ("1" or "0").

- 20        According to the present embodiment, the A/D converting unit 16 also functions as an output unit for the digital signal having a single bit (i.e., "1" or "0") in accordance with the change in analog signal which is outputted from the output terminal 40c of the resistor 40 and, in response to a switching operation of the switch 18, outputs either the digital signal having the plurality of bits or the digital signal having the single bit.

- 25        According to the present embodiment, the switch 18 is also controlled in response to a control signal which is sent from the game machine main body 100 on the basis of the game program which is recorded in the optical disk. That is, if the game program which is recorded in the optical disk is executed, the game machine main body 100 outputs a control signal for instructing the A/D converting unit 16 to function as an



level of the analog signal which is outputted by the resistor 40 within a predetermined range. There is a danger that it is impossible to output a digital signal which matches the state of the controller 11 if the predetermined range deviates from the range of levels of the analog signal (voltage) which is actually outputted by the resistor 40.

5           However, the resistor 40 and the conductive material 50 have individual differences and the power supply voltage also varies. Consequently, the individual control apparatuses 200 cause the output range of the analog signal outputted by the resistor 40 to differ.

10           Then, the control apparatus 200 according to the present embodiment comprises a segmenting-range setting unit 25 for individually setting the range of output levels of the analog signal which is segmented by the level segmenting unit 15 (refer to Fig. 37), and to thereby calibrate the range of levels of the analog signal (voltage) which is segmented by the level segmenting unit 15.

15           Fig. 38 is a diagram for explaining the function of the segmenting-range setting unit.

20           As shown in Fig. 38, a minimum value  $V_{min}$  and a maximum value  $V_{max}$  of the analog signal (voltage) which is outputted by the resistor 40 are initially set in advance in the segmenting-range setting unit 25. An arbitrary allowable value  $\alpha$  for the maximum value  $V_{max}$  is set in advance. The allowable value  $\alpha$  is set so as to compensate variations when the output (analog signal) of the resistor is recognized on the basis of information from the A/D converting unit 16. Further, a discriminating value  $\gamma$  around the minimum value  $V_{min}$  is set in advance so as to determine whether or not the control button is pressed.

25           For the setting, the segmenting range setting unit 25 executes the calibration operation as follows.

          When the power supply of the control apparatus 200 is turned on, the segmenting-range setting unit 25 recognizes a level  $V_{min}(\text{Real})$  of the analog signal

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In this case, considering the reason that the user presses the control button 221, etc., it is determined whether or not  $V_{min}(Real)$  is within the range of the allowable error value  $\gamma$  in which  $V_{min}$  is set to a center value. If  $V_{min}(Real)$  is out of the range  $(V_{min} + \gamma) > V_{min}(Real) > (V_{min} - \gamma)$ , the user is informed that the calibration is being performed.

Next, under the condition such that  $V_{\min}(\text{Real})$  is within the range  $(V_{\min} + \gamma) > V_{\min}(\text{Real}) > (V_{\min} - \gamma)$ , the value  $V_{\min}(\text{Real})$  is compared with  $V_{\min}$ . As a comparison, if  $V_{\min}(\text{Real}) > V_{\min}$ , the initial set value  $V_{\min}$  is set as the minimum value of the analog signal (voltage) which is outputted by the resistor 40. If  $V_{\min}(\text{Real}) < V_{\min}$ , the actual output value  $V_{\min}(\text{Real})$  is changed and set as the minimum value of the analog signal (voltage) which is outputted by the resistor 40.

If the value  $V_{\max}(\text{Real})$  is larger than  $(V_{\max} - \alpha)$  which is obtained by considering the allowable value  $\alpha$ , it is recognized that the user pressed the control button 221 up to the limit and  $V_{\max}(\text{Real})$  is compared with  $V_{\max}$ . As a comparison,  $V_{\max}(\text{Real}) < V_{\max}$ , the initial set value  $V_{\max}$  is set as the maximum value of the analog signal (voltage) which is outputted by the resistor 40. On the other hand, if  $V_{\max}(\text{Real}) > V_{\max}$ , the actual output value  $V_{\max}(\text{Real})$  is changed and set as the

maximum value of the analog signal (voltage) which is outputted by the resistor 40.

The segmenting range setting unit 25 controls the level segmenting unit 15 so as to uniformly segment the analog signal (voltage) which is outputted by the resistor 40 within the range from the minimum value  $V_{min}$  to the maximum value  $V_{max}$ , which are set as mentioned above.

Fig. 39A and Fig. 39B are diagrams showing deformed examples of the conductive member.

The conductive member 50 may have a shape in which the contact area with the resistor 40 can change in accordance with the contact pressure to the resistor 40, and is not limited to the peak-like shape shown in Figs. 34A to 34C. For example, the conductive member 50 can have a spherical shape shown in Fig. 39A or a shape having a plurality of projections whose heights are different as shown in Fig. 39B.

As shown in Fig. 40, the resistor 40 can be adhered to the inside of the ceiling surface of the elastic portion 222a which is formed in the elastic body 222 and can be disposed so as to face the conductive members 50.

Fig. 41 is a diagram showing a structural example of the first control unit according to the present embodiment.

According to the structural example shown in the figure, the conductive members 50 are adhered to the inside of ceiling surface of the elastic body 213, corresponding to the control keys 211a (controller 11) of the cross-shaped control body 211. The resistor 40 having the single structure is disposed so as to face the conductive members 50.

Fig. 42 is a diagram showing a circuit construction of the resistor. As shown in the figure, the resistor 40 is inserted in series with the power line 13 and a voltage is applied across the electrodes 40a and 40b. The internal resistance of the resistor 40 is schematically divided into first and second variable resistors 43 and 44 shown in the figure. For instance, the conductive member 50 which moves together with the control



key 211a (up directional key) for moving the character upward makes contact with a portion of first variable resistor 43 and the conductive member 50 which moves together with the control key 211a (left directional key) for moving to the left makes contact therewith, thereby changing the resistance in accordance with the contact area with the conductive members 50. For instance, the conductive member 50 which moves together with the control key 211a (down directional key) for moving the character downward makes contact with the second variable resistor 44 and the conductive member 50 which moves together with the control key 211a (right directional key) for moving to the right makes contact therewith, thereby changing the resistance in accordance with the contact area with the conductive members 50.

The output terminal 40c is provided at an intermediate portion between the variable resistors 43 and 44, and the analog signal is outputted from the output terminal 40c in accordance with the pressure on the control keys 211a (controller 11).

The outputs from the output terminal 40c can be calculated by using a dividing ratio of the resistances of the first and second variable resistors 43 and 44. If the resistance of the first variable resistor 43 is R1, the resistance of the second resistor 44 is R2, and the power supply voltage is Vcc, an output voltage V generated at the output terminal 40c can be expressed by the following expression.

$$V = V_{cc} \times R2 / (R1 + R2)$$

Therefore, when the resistance of the first variable resistor 43 decreases, the output voltage increases. On the other hand, when the resistance of the second variable resistor 44 decreases, the output voltage decreases.

Fig. 43 is a diagram showing the characteristics of the analog signal (voltage) which is outputted by the output terminal 40c of the resistor.

First of all, a voltage is applied to the resistor 40 when the power is turned on, so that a predetermined analog-signal (voltage)  $V_0$  is outputted by the output terminal 40c unless the control keys 211a of the controller 221 are pressed.

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Next, if any one of control keys 211a is pressed, the output from the resistor 40 is kept at  $V_0$  and does not change because the resistance of the resistor 40 does not change until the conductive member 50 makes contact with the resistor 40.

Moreover, the up directional key or the left directional key is pressed and the conductive member 50 makes contact with the first variable resistor 43 in the resistor 40 (a pressed position p in the figure) and, thereafter, the contact area of the conductive member 50 for the first variable resistor 43 increases corresponding to the pressure on the control key 211a (controller). Thus, the resistance corresponding to the position decreases and the analog signal (voltage) which is outputted by the output terminal 40c in the resistor 40 is increased. When the conductive member 50 is deformed to the greatest extent, the analog signal (voltage) which is outputted by the output terminal 40c in the resistor 40 is set to the maximum value  $V_{max}$  (a pressed position q in the figure).

On the contrary, the down directional key or right directional key is pressed and the conductive member 50 makes contact with the second variable resistor 44 in the resistor 40 (a pressed position r in the figure) and, thereafter, the contact area of the conductive member 50 for the second variable resistor 44 increases corresponding to the pressure on the control key 211a (controller). Thus, the resistance corresponding to the position decreases and this results in decreasing the analog signal (voltage) which is outputted by the output terminal 40c in the resistor 40. When the conductive member 50 is deformed to the greatest extent, the analog signal (voltage) which is outputted by the output terminal 40c in the resistor 40 is set to the minimum value  $V_{min}$  (a pressed position s in the figure).

The analog signal (voltage) which is outputted by the output terminal 40c in the resistor 40 is inputted to the level segmenting unit 15, as shown in Fig. 44. The level segmenting unit 15 segments the output level of the analog signal into a plurality of levels and, further, the A/D converting unit 16 converts the analog signal which is outputted by the resistor 40 into the digital signal in accordance with the segmented

output-level. Incidentally, the functions of the level segmenting unit 15, the A/D converting unit 16, and the switch 18 which are shown in Fig. 44 have been described above with reference to Fig. 37, and the detailed description thereof is omitted.

The value  $V_0$  during the non-pressed state and the minimum value  $V_{min}$  and the maximum  $V_{max}$  of the analog signal (voltage) which is outputted by the resistor 40 are initially set, in advance, in the segmenting-range setting unit 25 for individually setting the range of output levels of the analog signal which is segmented by the level segmenting unit 15, as shown in Fig. 45. An arbitrary allowable value  $\alpha$  for the maximum value  $V_{max}$  is preset and an arbitrary allowable value  $\beta$  for the minimum value  $V_{min}$  is preset. The allowable values  $\alpha$  and  $\beta$  compensate for variations when the output (analog signal) of the resistance is recognized on the basis of the information from the A/D converting unit 16. Further, a discriminating value  $\gamma$  around the value  $V_0$  of the analog signal (voltage) which is outputted in the non-pressed state is preset so as to determine whether or not the control button is pressed.

For the setting, the segmenting-range setting unit 25 executes the calibration operation as follows.

When the power supply of the control apparatus 200 is turned on, the segmenting range setting unit 25 first recognizes, on the basis of information from the A/D converting unit 16 in order to adjust the level  $V_0$  of the analog signal (voltage) which is outputted by the resistor 40 in the non-pressed state, a level  $V_0(\text{Real})$  of the analog signal (voltage) which is actually outputted by the resistor 40.

In this case, considering the reason that the user presses the control button 221, etc., it is determined whether or not  $V_0(\text{Real})$  is within the range of the allowable error value  $\gamma$  in which  $V_0$  is set as a central value. If  $V_0(\text{Real})$  is out of a range  $(V_0 + \gamma) > V_0(\text{Real}) > (V_0 - \gamma)$ , the user is informed that the calibration is being performed.

To the user, it is possible to adopt methods of switching on/off the display unit 253 provided in the control apparatus 200 and operating a vibration mechanism if such

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directional key up to the limit and  $V_{\min}(\text{Real})$  is compared with  $V_{\min}$ . As a comparison, if  $V_{\min}(\text{Real}) > V_{\min}$ , the initial set value  $V_{\min}$  is set as the minimum value of the analog signal (voltage) which is outputted by the resistor 40. On the other hand, if  $V_{\min}(\text{Real}) < V_{\min}$ , the actual output value  $V_{\min}(\text{Real})$  is changed and set as the minimum value of the analog signal (voltage) which is outputted by the resistor 40.

The similar operation is performed in the case of the right directional key. The minimum value  $V_{\min}$  of the analog signal (voltage) which is outputted by the resistor 40 in accordance with the operation for pressing the right directional key is set.

The segmenting-range setting unit 25 controls the level segmenting unit 15 so as to uniformly segment the analog signal (voltage) which is outputted by the resistor 40 within the range from the output  $V_0$  in the non-pressed state to the maximum value  $V_{\max}$ , which are set as mentioned above, in response to the pressing operation of the up directional key and the left directional key. The segmenting-range setting unit 25 controls the level segmenting unit 15 so as to uniformly segment the analog signal (voltage) which is outputted by the resistor 40 within the range from the output  $V_0$  in the non-pressed state to the minimum value  $V_{\min}$ , which are set as mentioned above, in response to the pressing operation of the down directional key and the right directional key.

Incidentally, in the above description, the up directional key and the left directional key are assigned to the first variable resistor portion in the resistor 40 and the down directional key and the right directional key are assigned to the second variable resistor portion in the resistor 40. However, the present invention is not limited to the above description and, obviously, it is possible to arbitrarily set the allocation between the keys and the variable resistor portions.

With respect to the first control unit 210, the resistor 40 can also be individually arranged at the conductive members 50 which are provided at positions corresponding to the control keys 221a of the control body 211, so as to have the circuit construction

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shown in Fig. 35. In this case, the characteristics of the analog signal (voltage) which is outputted by the output terminal 40c in the resistor 40 are those shown in Fig. 36.

Furthermore, the present invention is not limited to the above-described embodiments.

5        The control apparatus according to the present invention is not limited to being applied to the control apparatus 200 for the video game machine shown in Fig. 2. It is possible to apply the control apparatus according to the present invention, for instance, to various control apparatuses in which the function can be improved by enabling digital operation and analog operation.

10        As mentioned above, according to the present invention, the analog signal corresponding to the pressing operation of the controller is converted into the digital signal and the converted digital signal is outputted. Therefore, it is possible to realize digital operation by the controller for pressing operation and also to output the digital signal by the uniform level segmentation without individual differences of the detecting  
15        devices and variations in the voltage which is applied to the detecting devices, etc.

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## CLAIMS

## WHAT IS CLAIMED IS:

## 1. A control apparatus comprising:

- 5           a controller which can be pressed and operated;  
          a detecting device for outputting an analog signal corresponding to the pressing operation of said controller;  
          a level segmenting unit for segmenting the analog signal which is outputted by said detecting device in accordance with the pressing operation of said controller into a  
10   plurality of levels;  
          an A/D converting unit for converting said analog signal into a digital signal in accordance with the output level which is segmented by said level segmenting unit; and  
          a segmenting-range setting unit for setting a range of output levels of the analog signal which is segmented by said level segmenting unit,  
15   wherein the plurality of levels into which the analog signal outputted by said detecting device is segmented by said level segmenting unit are within the range which is set by said segmenting-range setting unit.

2. An apparatus according to Claim 1, further comprising a switch for switching the  
20   outputted signal to either one of a digital signal having a plurality of bits and a digital signal having a single bit, said switch being connected to said A/D converting unit.

3. An apparatus according to Claim 1, wherein  
          said segmenting-range setting unit comprises a storing unit, and  
25   the plurality of output levels, which are within the range of output levels of the analog signal, into which the analog signal outputted by said detecting device are segmented by said level segmenting unit are stored in said storing unit.

4. An apparatus according to Claim 3, wherein, in place of said storing unit in said control apparatus, a storing unit in an entertainment device serving as a main body to which said control apparatus is connected is used.

5

5. An apparatus according to Claim 1, wherein

said segmenting-range setting unit is a volume device that is inserted in a power line to which said detecting device is connected, and

the plurality of levels within the range of the output levels, into which the analog signal outputted by said detecting device is segmented by said level segmenting unit is detected by said volume device.

6. An apparatus according to Claim 1, wherein said segmenting-range setting unit comprises:

15 a volume device that is inserted in a power line to which said detecting device is connected;

a storing unit for storing a limit value of a range of the output levels of the analog signal which is segmented by said level segmenting unit; and

a comparator for comparing the range of the output levels, which is detected by said volume device with the limit value which is stored in said storing unit,

20 wherein said comparator outputs the range of output levels which is detected by said volume device to said level segmenting unit when said range of output levels is within the limit value which is stored in said storing unit, and outputs the limit value which is stored in said storing unit to said level segmenting unit when the output level  
25 which is detected by said volume device is over said limit value.

7. An apparatus according to Claim 1, further comprising a projection which is formed



at the bottom of said controller, and an elastic body having a concave portion which engages with and supports said projection, wherein said detecting device is pressed due to deformation of said elastic body.

- 5 8. An apparatus according to Claim 1, further comprising a flat surface which is formed at the bottom of said controller, and an elastic body having a flat surface which engages with and supports said flat surface, wherein said detecting device is pressed due to deformation of said elastic body.

- 10 9. An apparatus according to Claim 7 or 8, wherein said detecting device comprises an internal board.

10. An apparatus according to Claim 1, further comprising:

a switch;

- 15 a digital switch serving as an ON/OFF switch provided in said controller; and  
a digital signal generating unit for outputting a digital signal having a single bit, said digital signal generating unit being connected to said digital switch,

wherein said switch switches an output of the digital signal generating unit and the output of said A/D converting unit.

20

11. An apparatus according to Claim 10, further comprising:

an elastic body which engages with and supports the bottom of said controller;

a first sheet member and a second sheet member; and

- 25 first and second fixed terminals provided in said digital switch which are pressed due to deformation of said elastic body and which are provided on one side of said first sheet member,

wherein said detecting device is provided on one side of said second sheet

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which can be pressed and operated, a detecting device for outputting an analog signal corresponding to the pressing operation of said controller, a level segmenting unit for segmenting the analog signal which is outputted by said detecting device in accordance with the pressing operation of said controller into a plurality of levels, and an A/D  
5 converting unit for converting said analog signal into a digital signal in accordance with the output level which is segmented by said level segmenting unit, said control apparatus being connected to an entertainment device having a function of a program, said method comprising the steps of:

outputting, by said entertainment device, a control guide on the basis of a  
10 predetermined adjusting program;

storing the output level of the analog signal which is outputted by said detecting device in a storing unit which is built in or connected to said entertainment device; and

segmenting, by said level segmenting unit, the analog signal which is outputted by said detecting device into a plurality of levels on the basis of said output level which  
15 is stored in said storing unit.

17. A method according to Claim 16, further comprising the step of storing the output level of the analog signal which is outputted by said detecting device in a memory card as said storing unit, which is detachably connected to the entertainment device, by  
20 pressing and operating said controller in accordance with said control guide.

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**ABSTRACT OF THE DISCLOSURE**

An analog operation is possible by a pressing operation of a controller which is normally used for conventional digital operation. A detecting device (e.g., a pressure-sensitive device) for outputting an analog signal corresponding to the pressing operation by the controller is provided, the analog signal which is outputted by the detecting device is segmented into levels by a level segmenting unit, and the segmented analog signal is converted into a digital signal having a plurality of bits corresponding to the output level by an A/D converting unit. A segmenting-range setting unit (such as a memory) for setting the range of output levels of the analog signal which is segmented by the level segmenting unit is also provided. The level segmenting unit segments the output level of the analog signal which is outputted by the detecting device within the range which is set by the segmenting-range setting unit.

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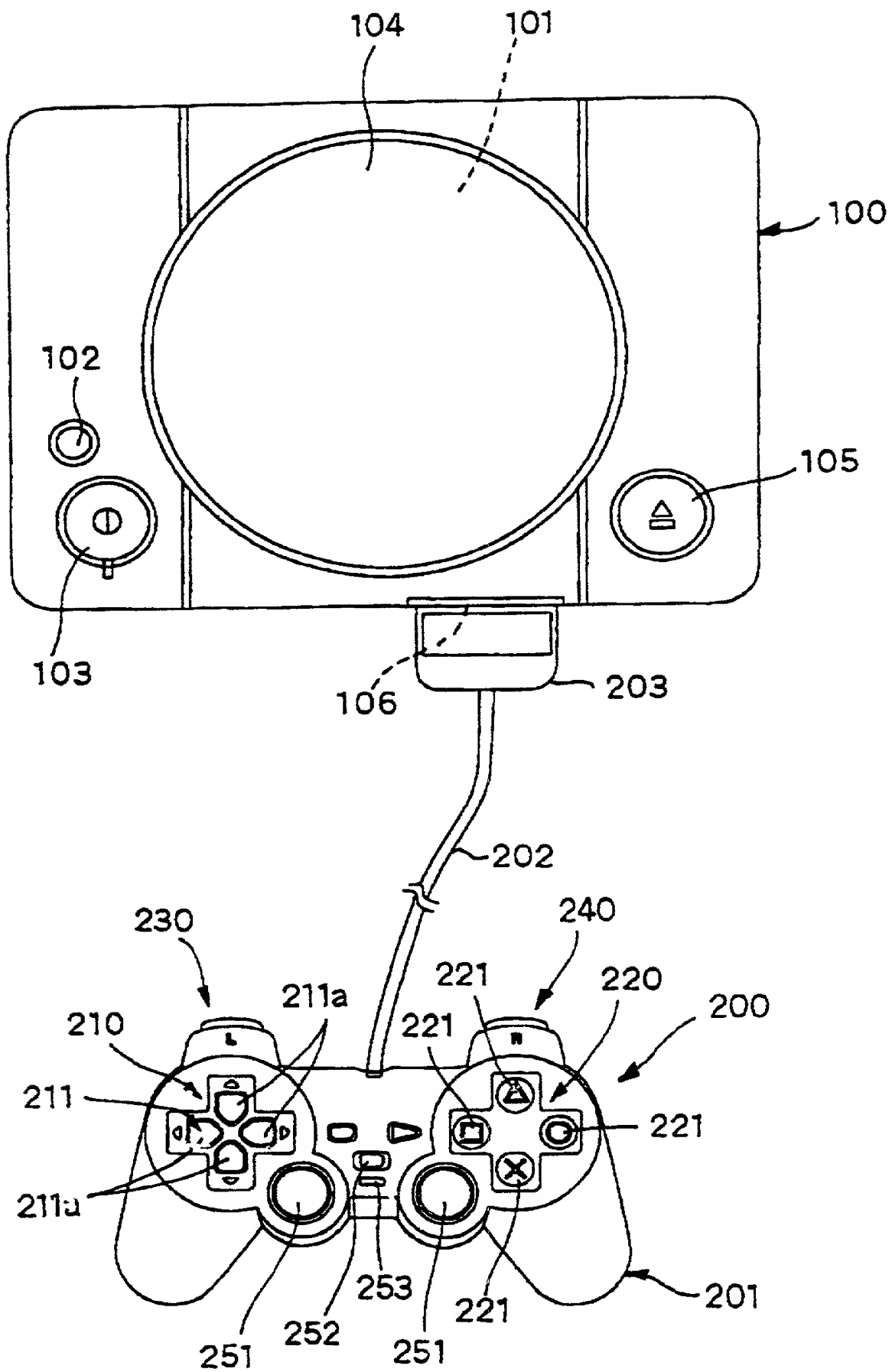


FIG. 1

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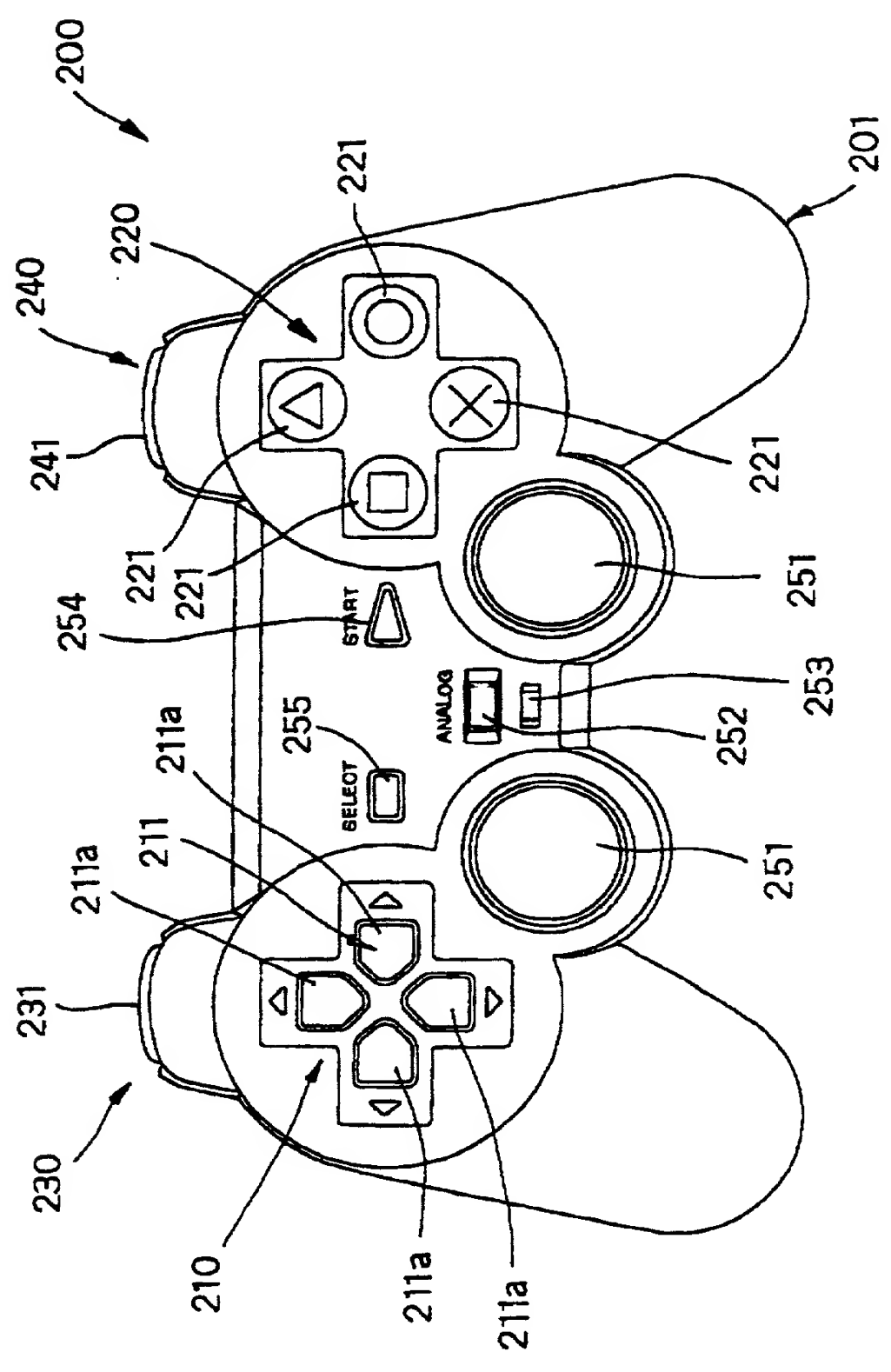


FIG. 2







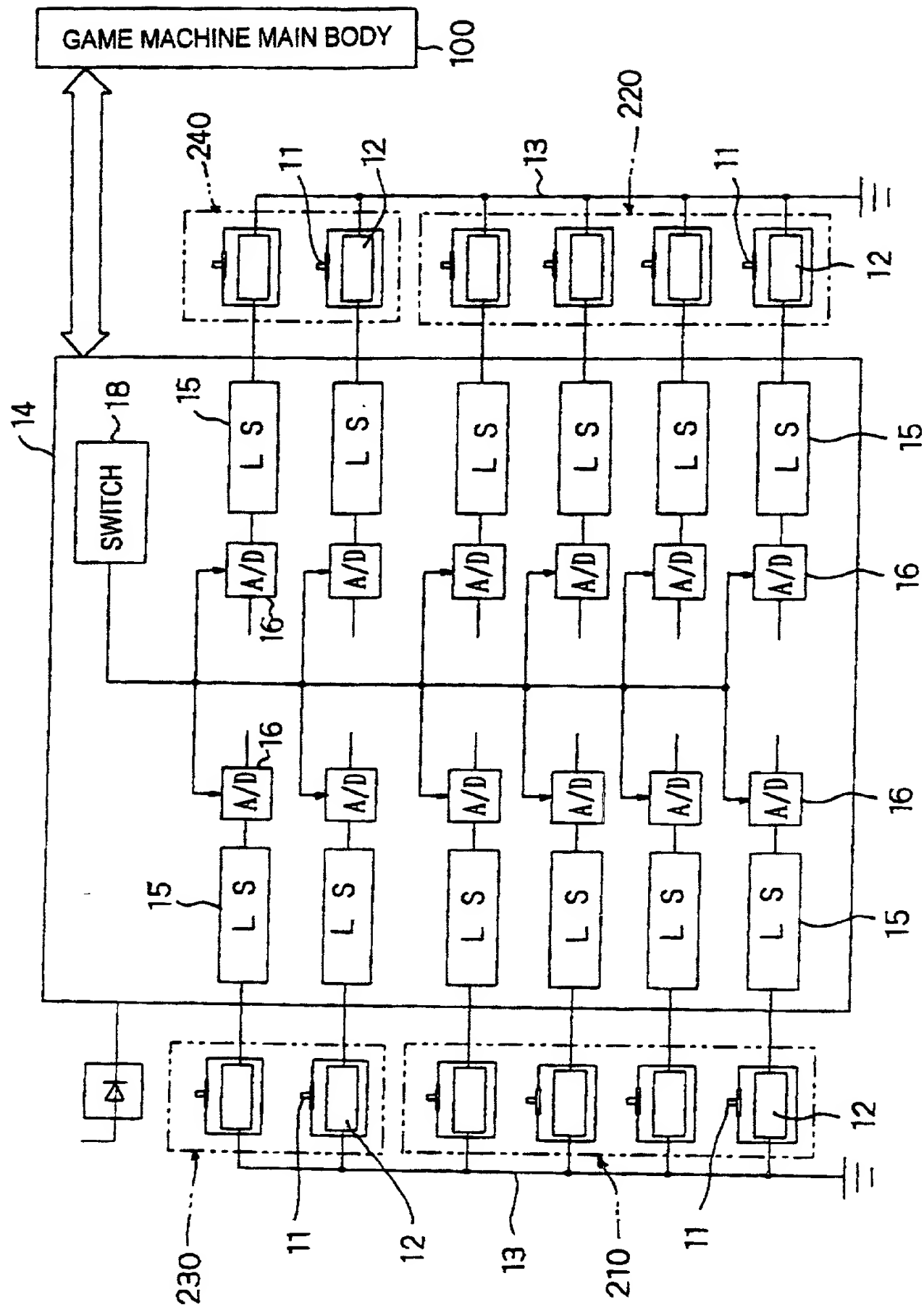


FIG. 5



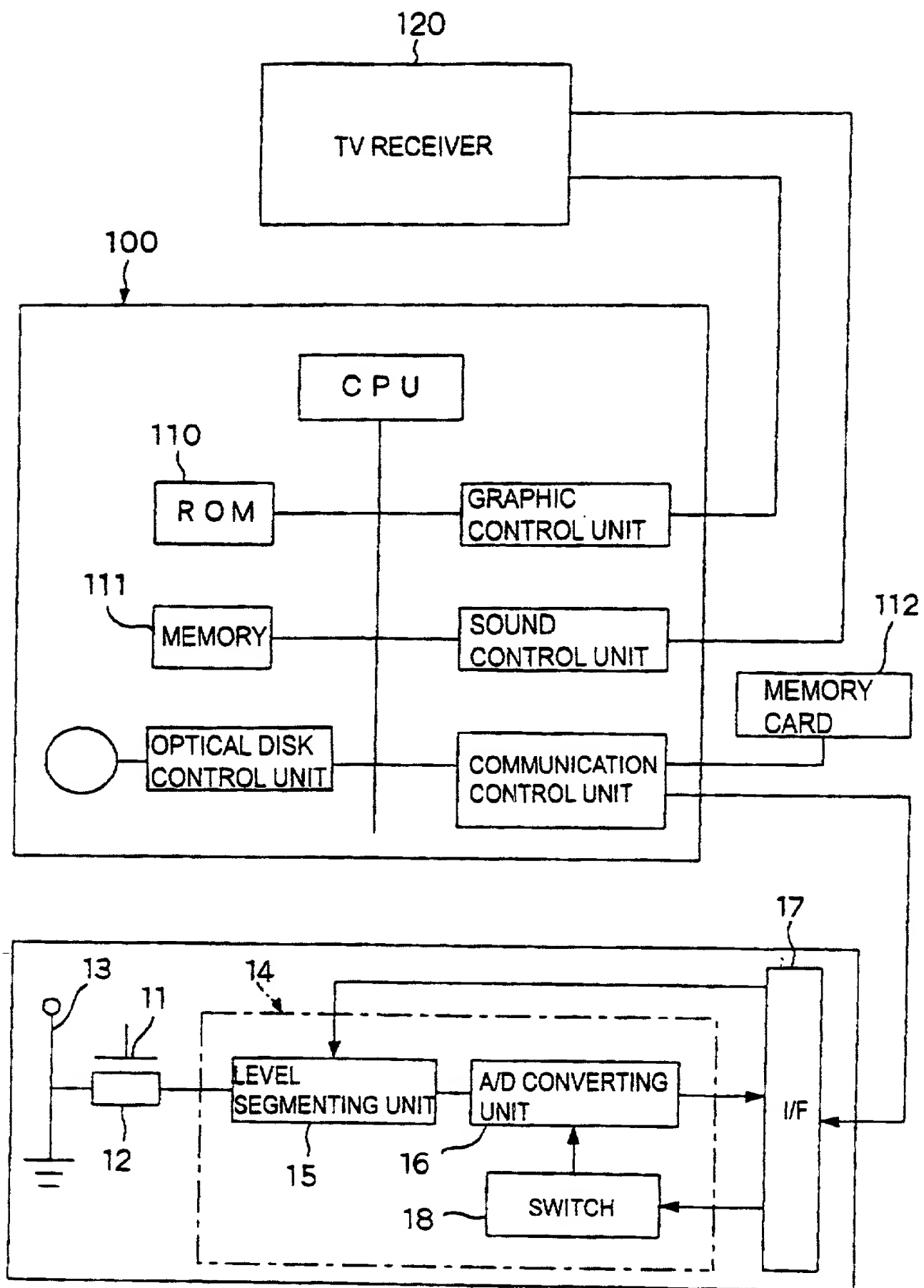


FIG. 7



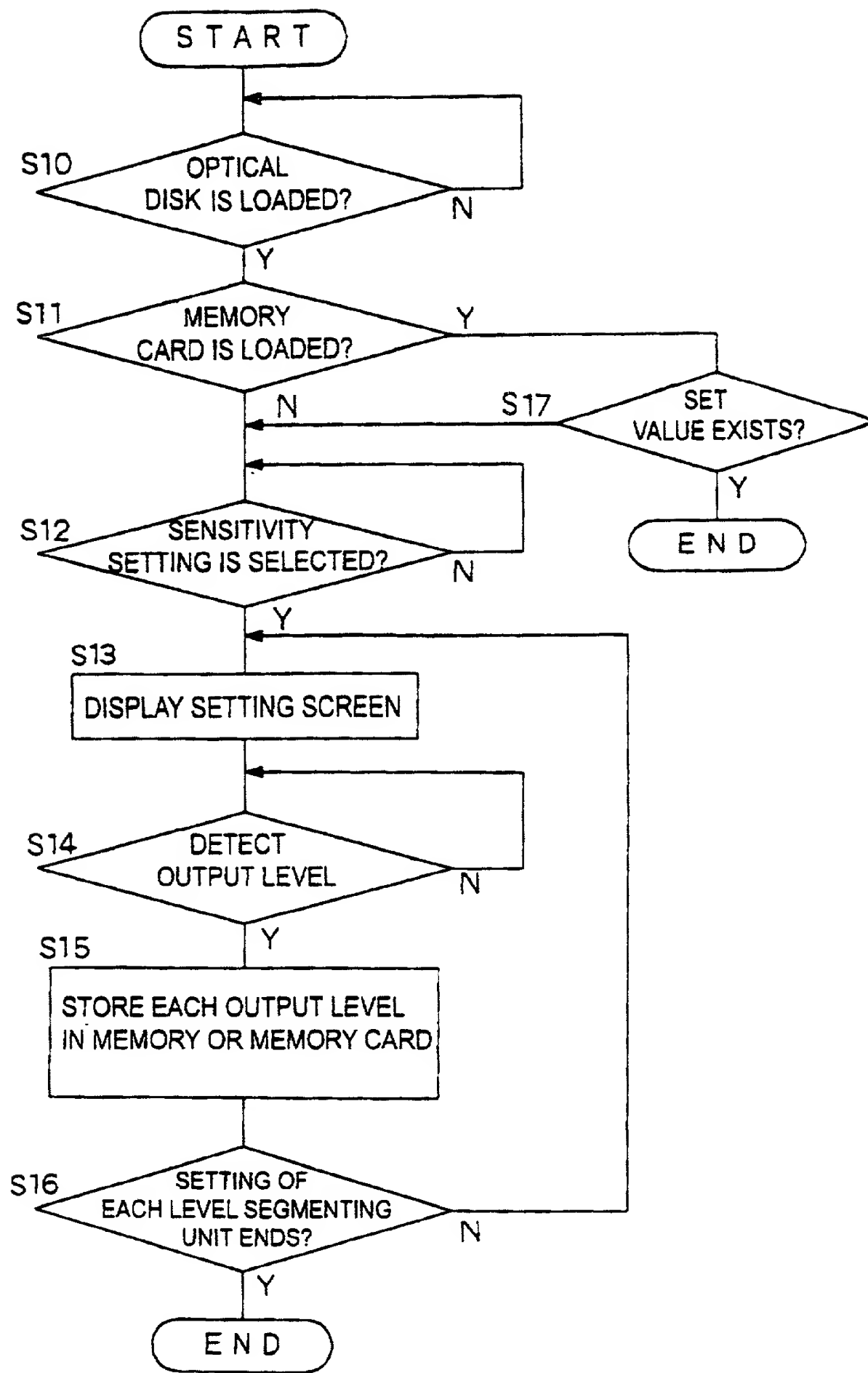


FIG. 9





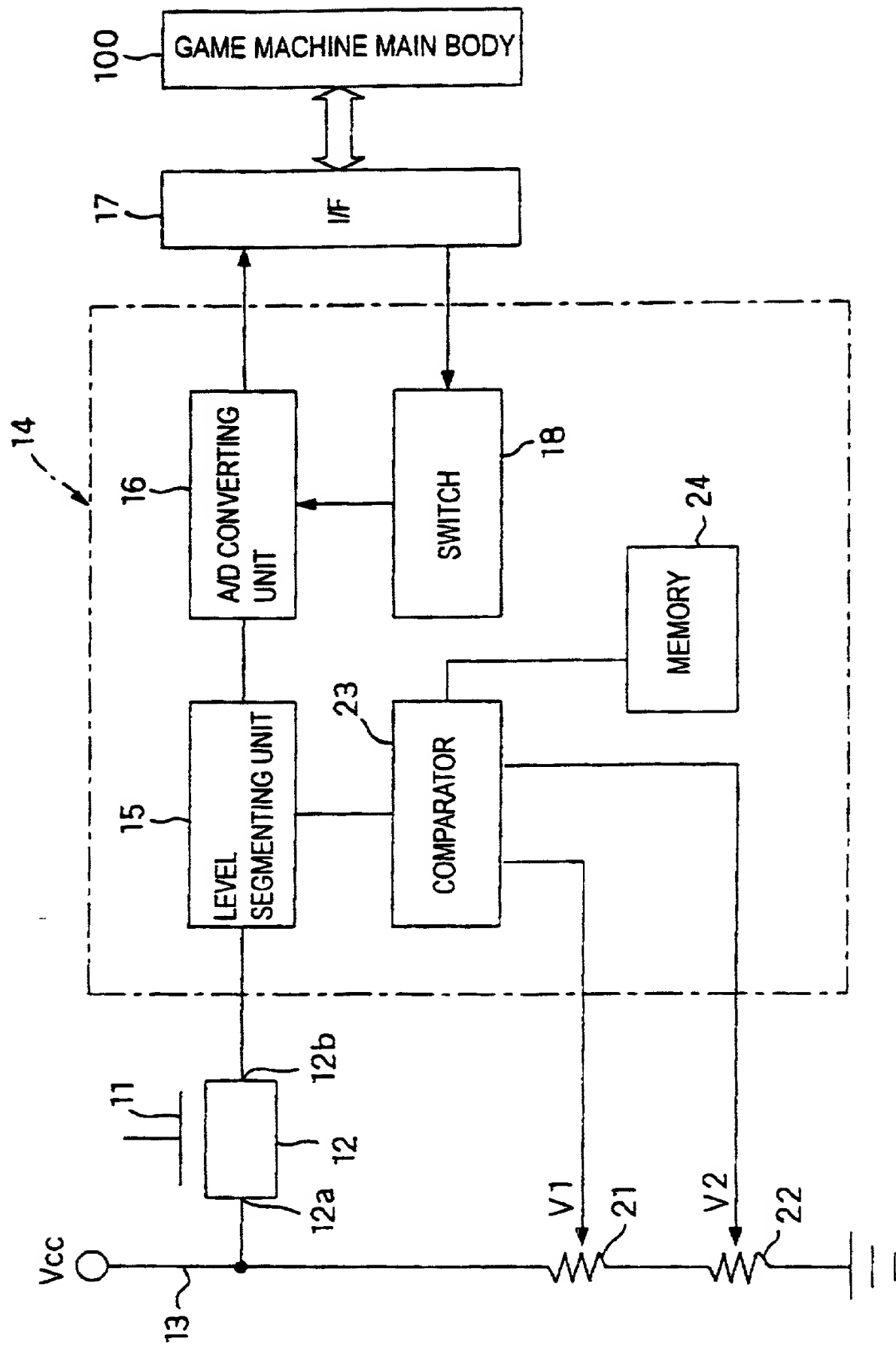


FIG. 12



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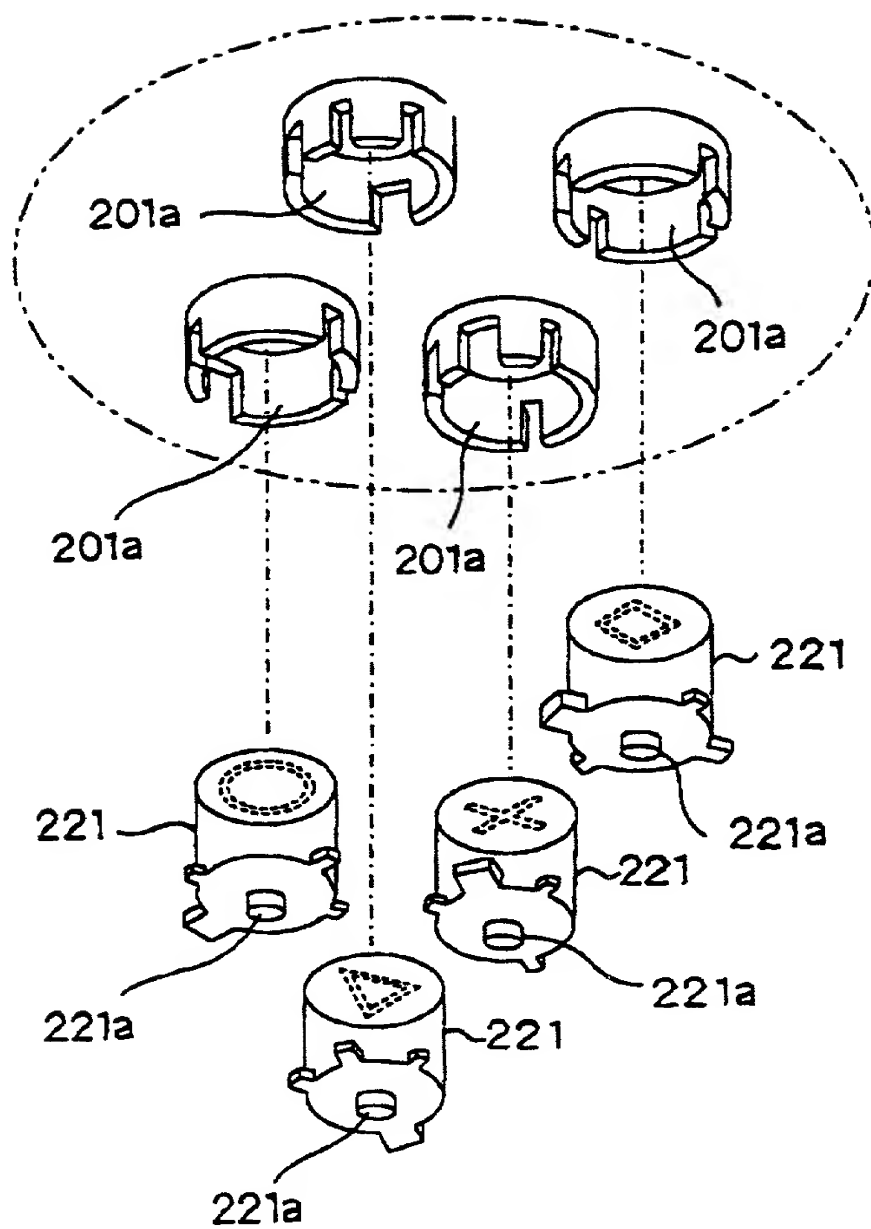


FIG. 13

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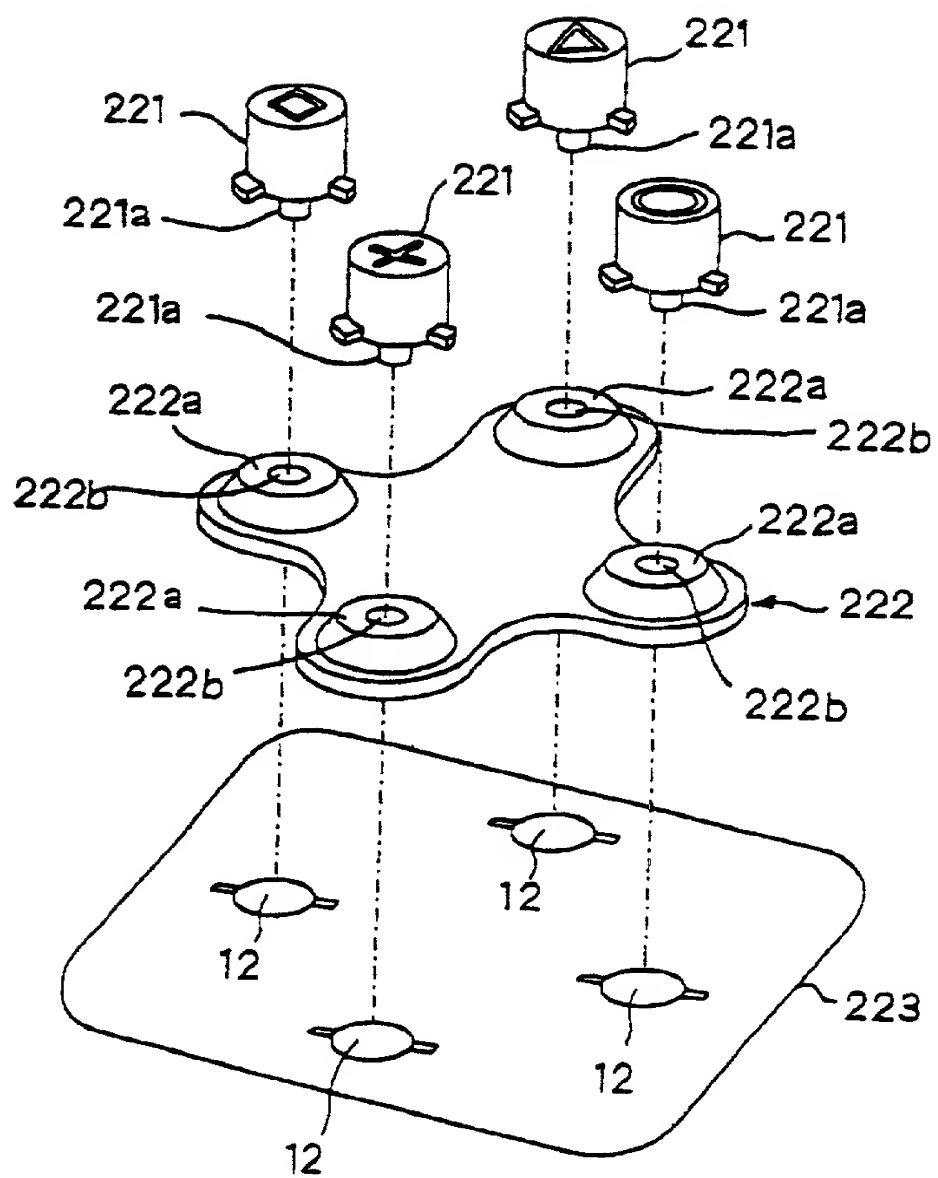


FIG. 14

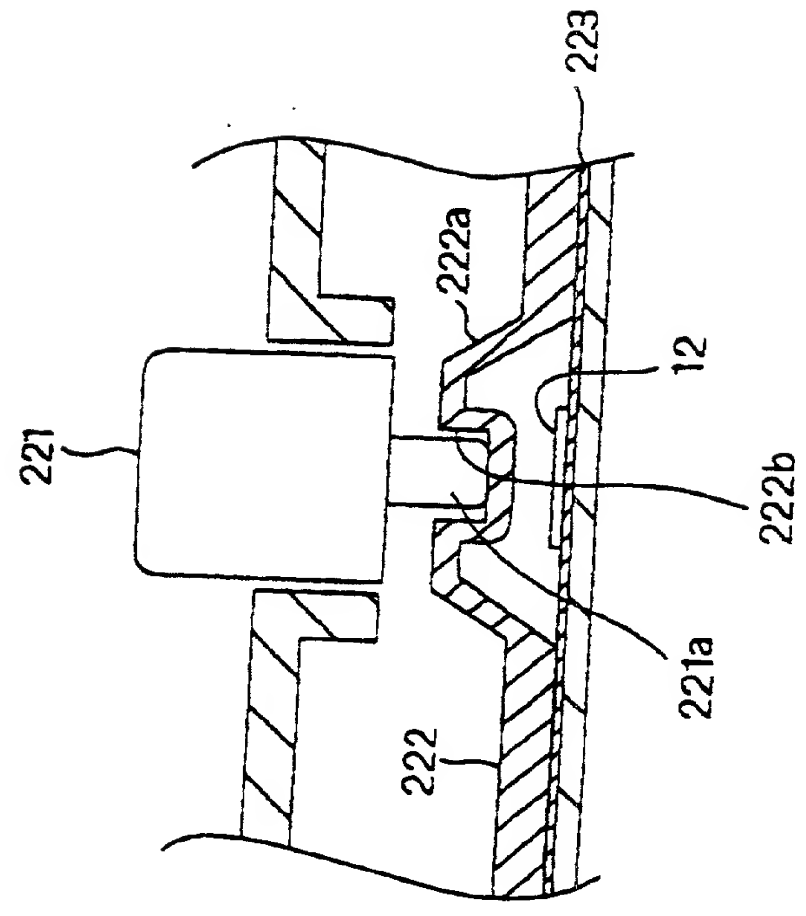


FIG. 15



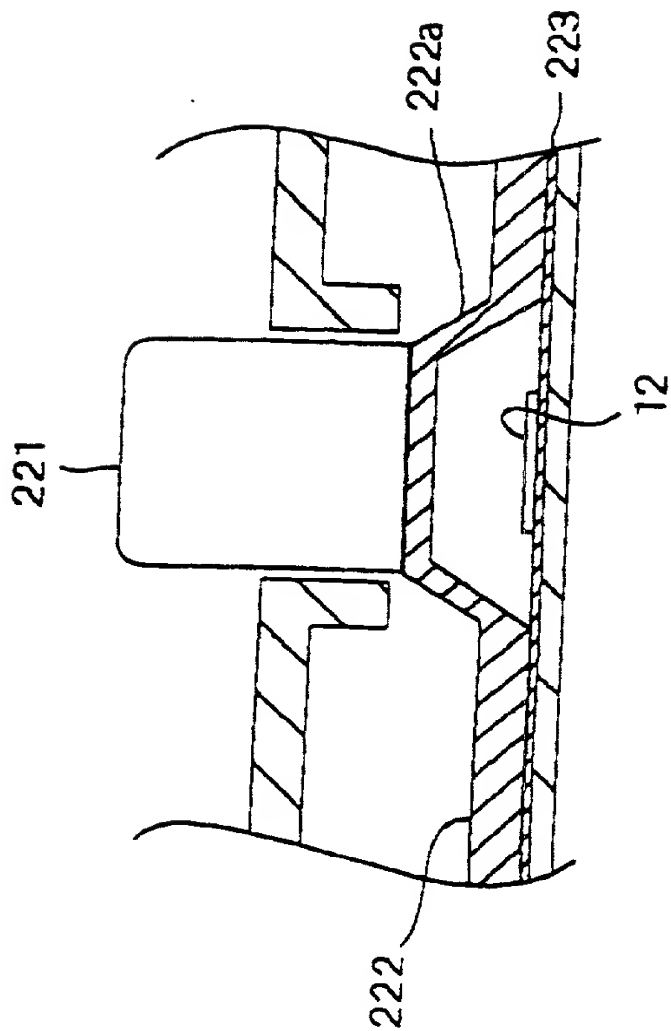


FIG. 17



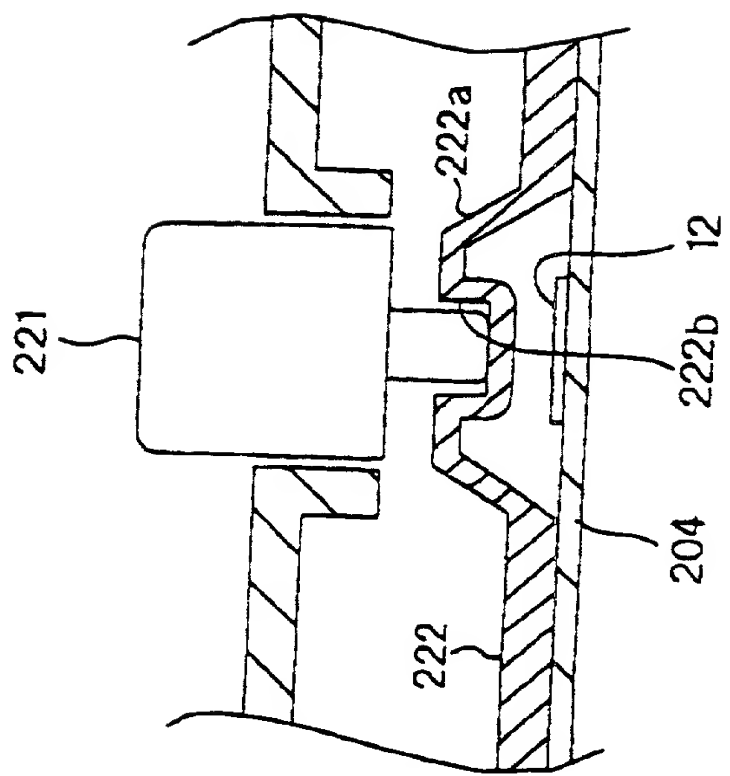


FIG. 19

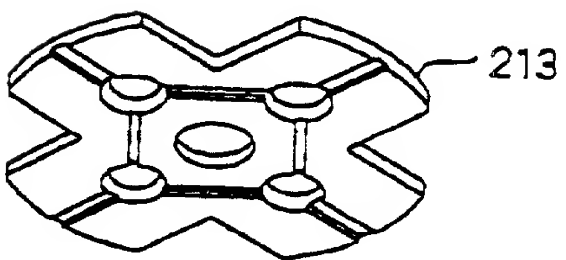
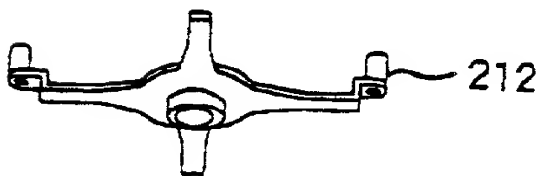
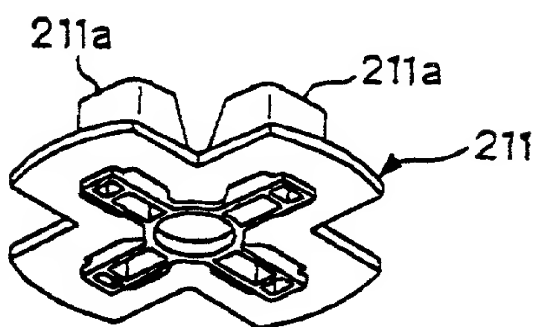
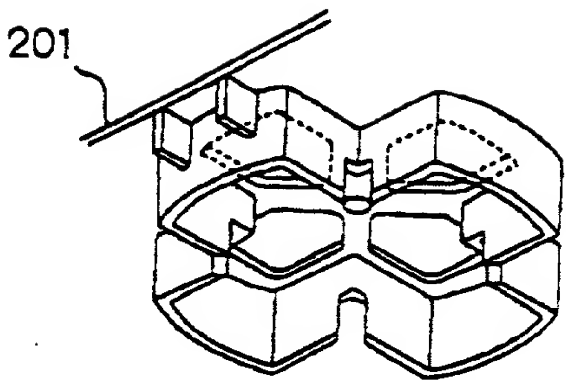


FIG. 20





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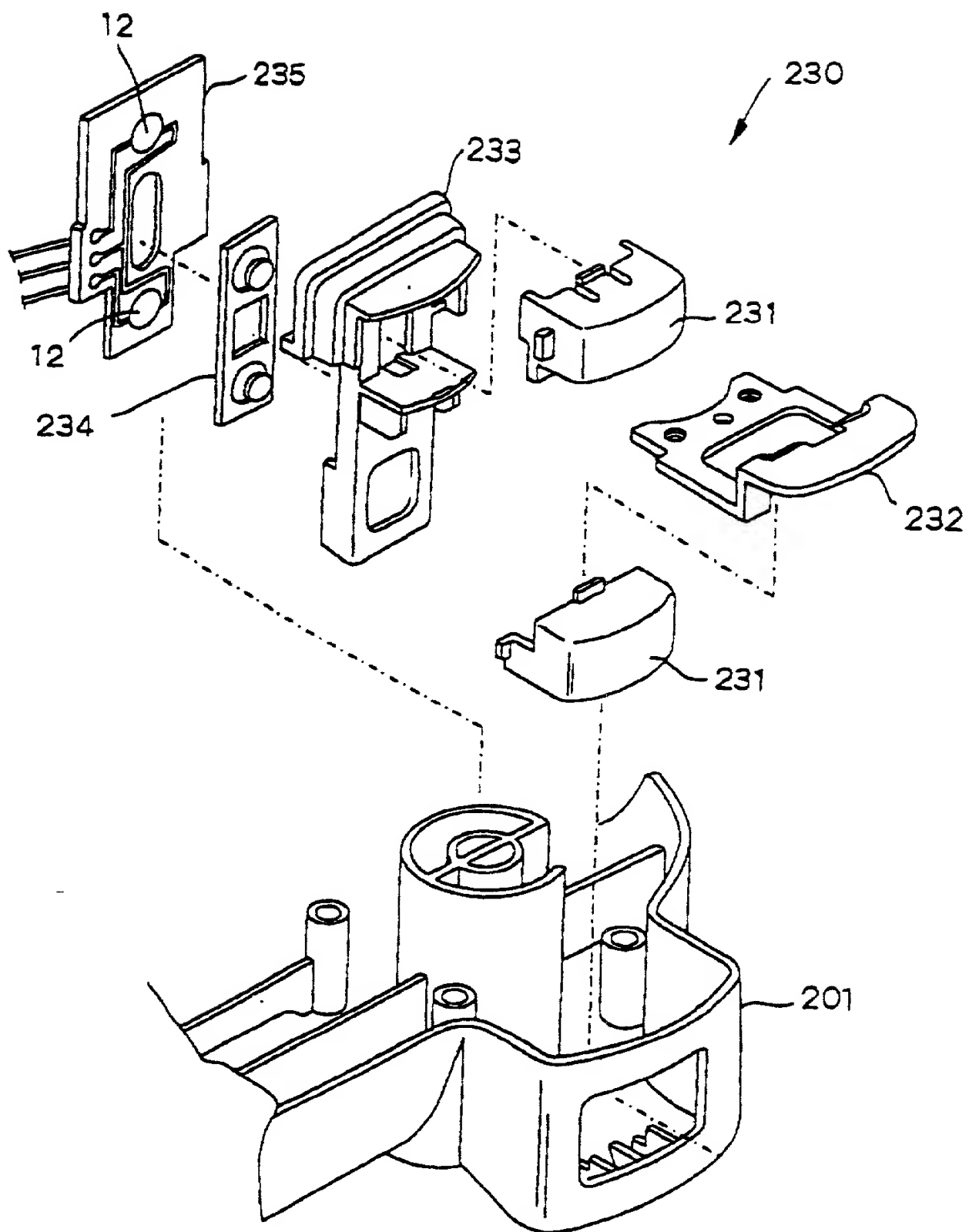


FIG. 22

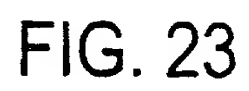
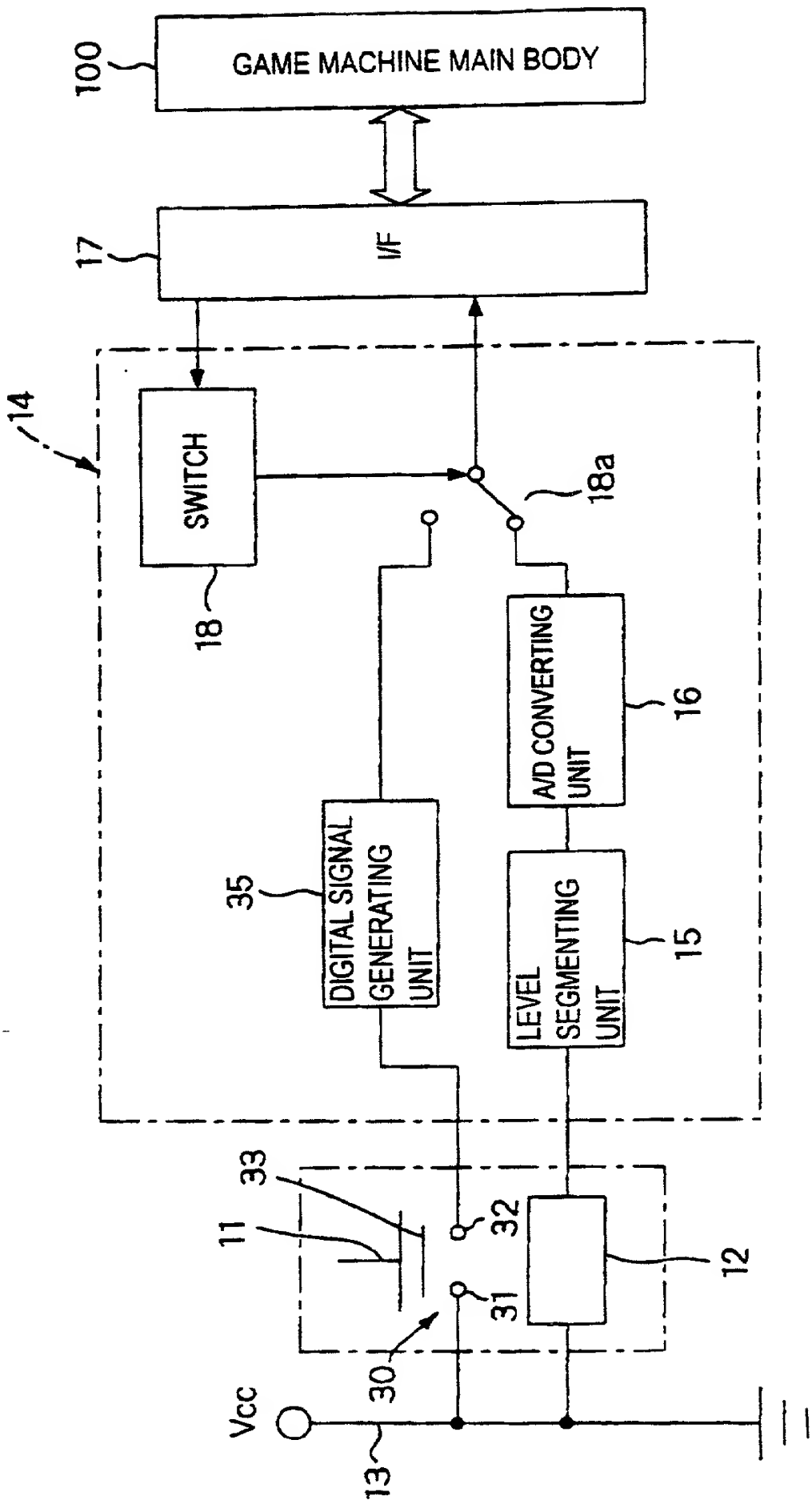


FIG. 23



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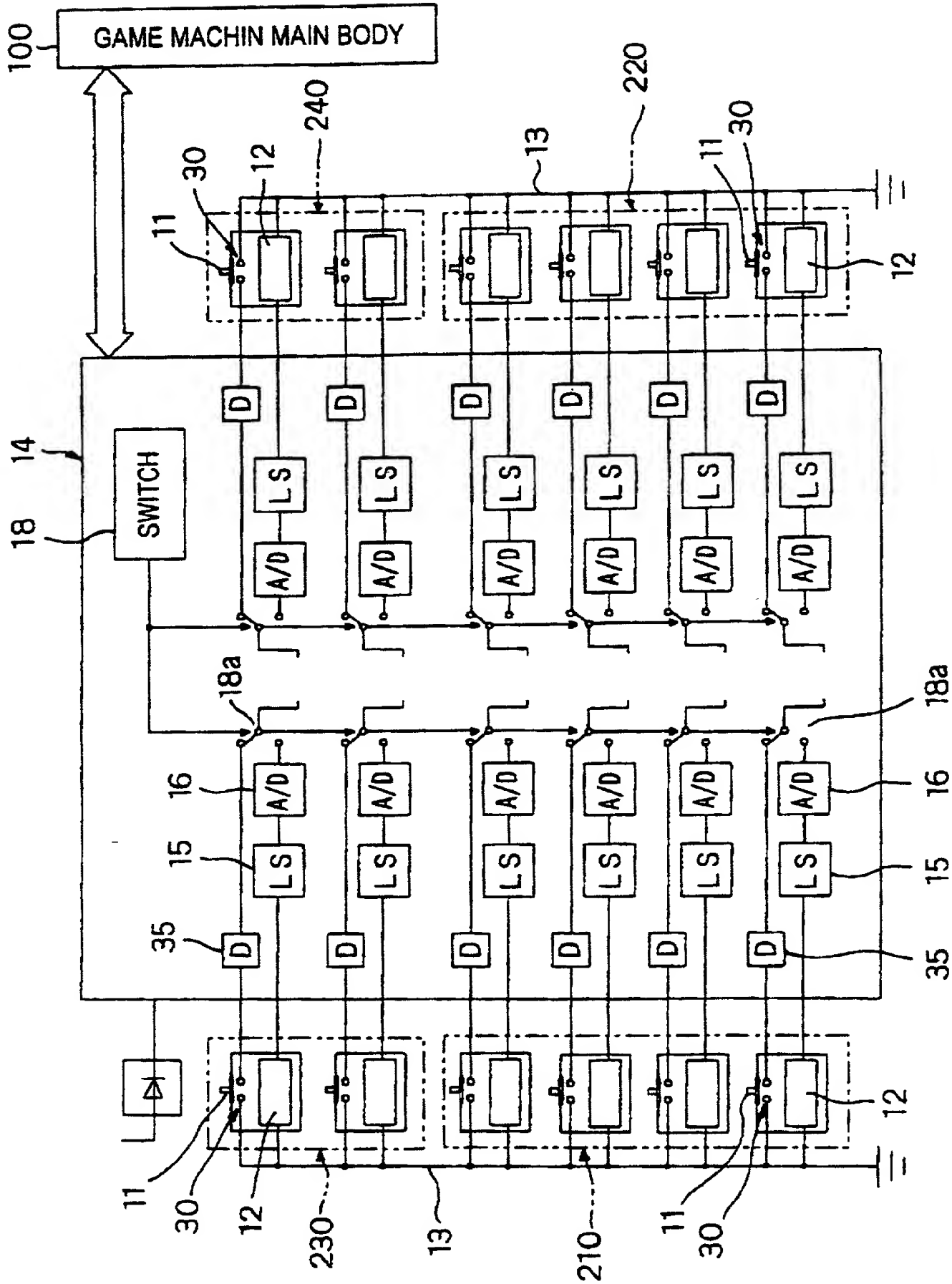
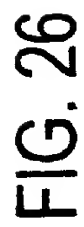


FIG. 25



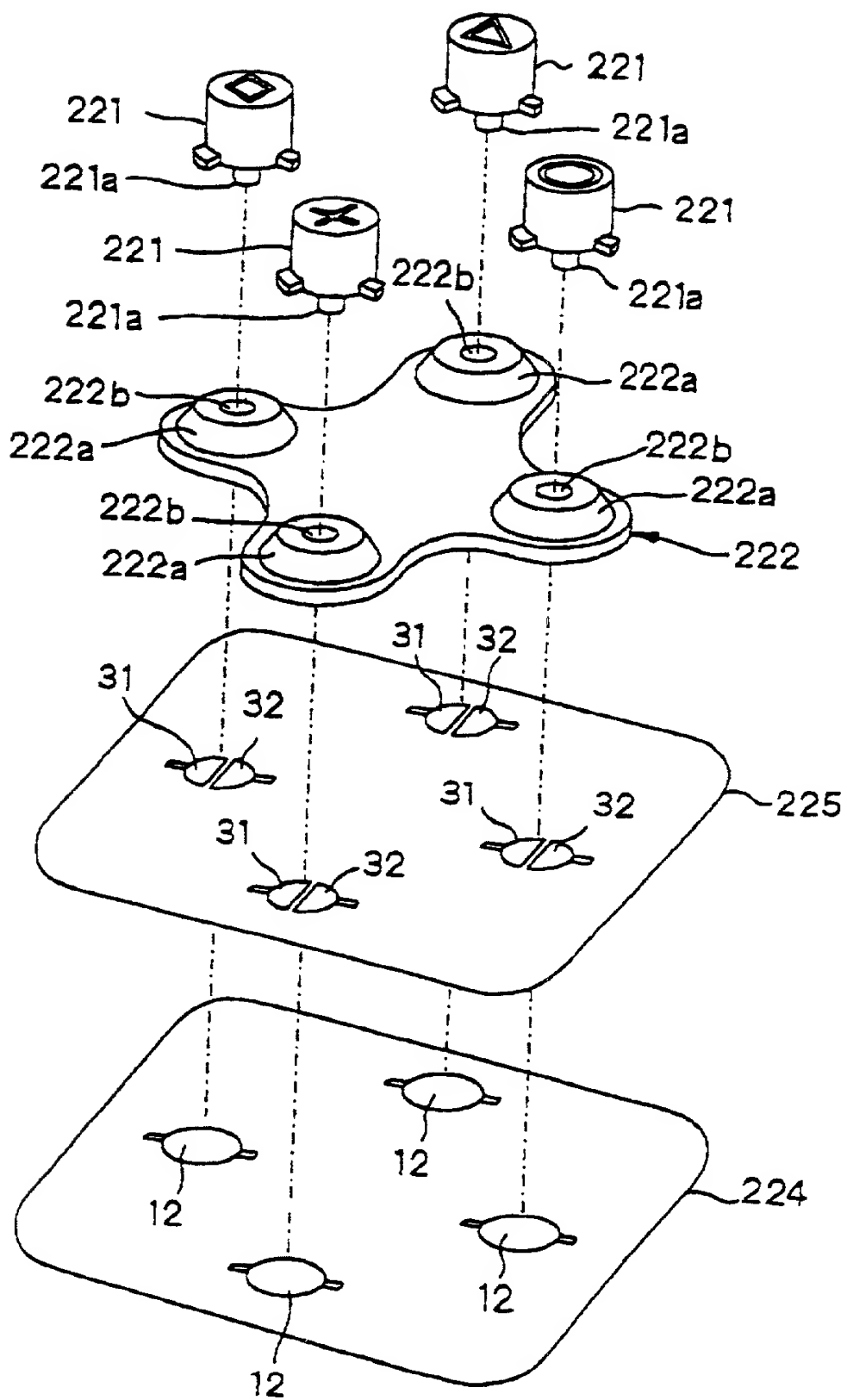


FIG. 27





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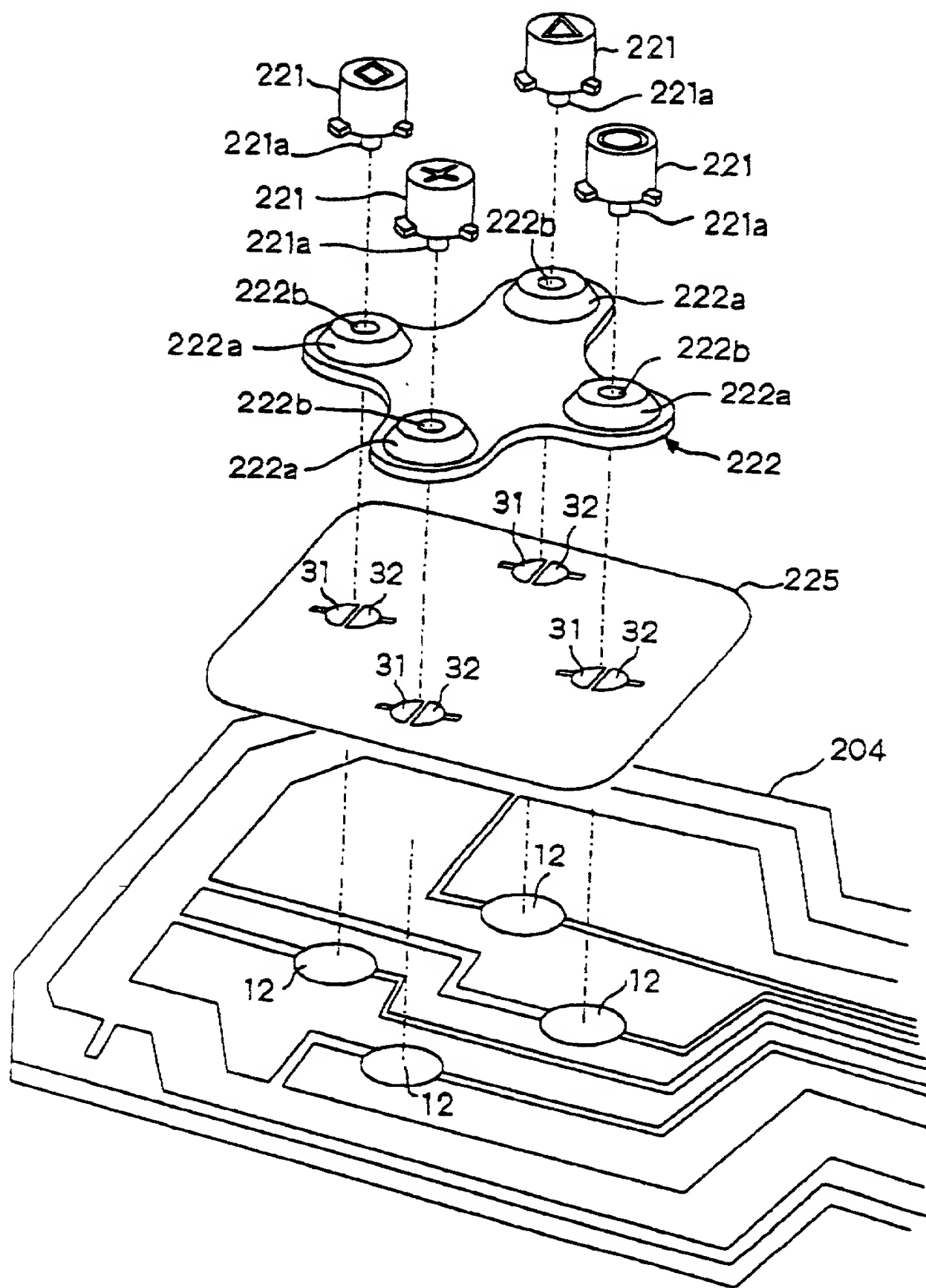
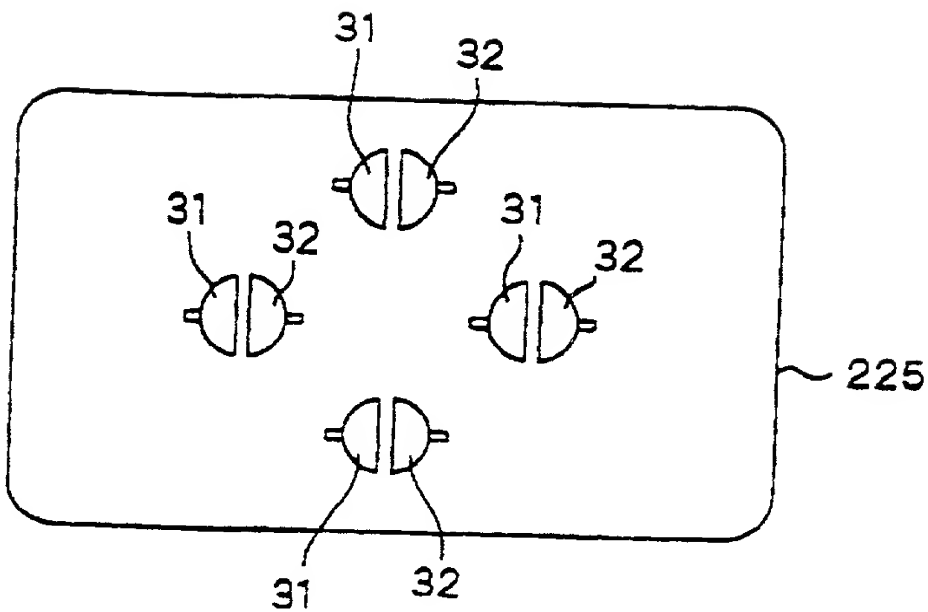


FIG. 29



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(A)



(B)

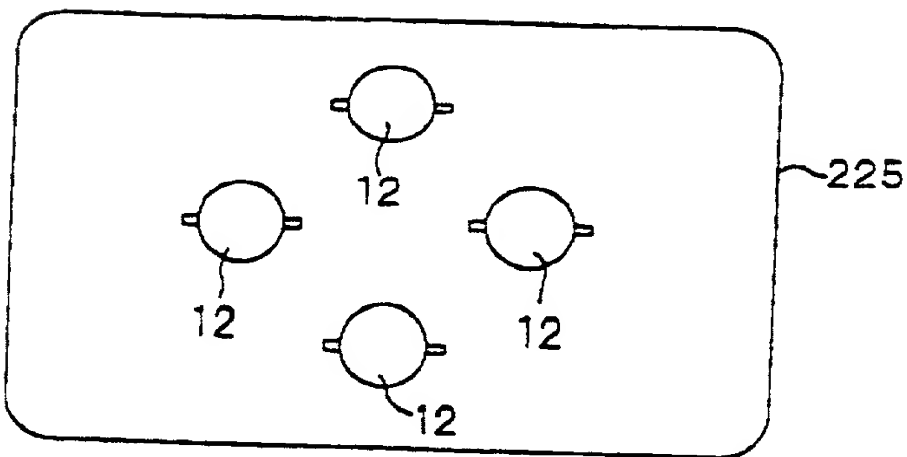


FIG. 31



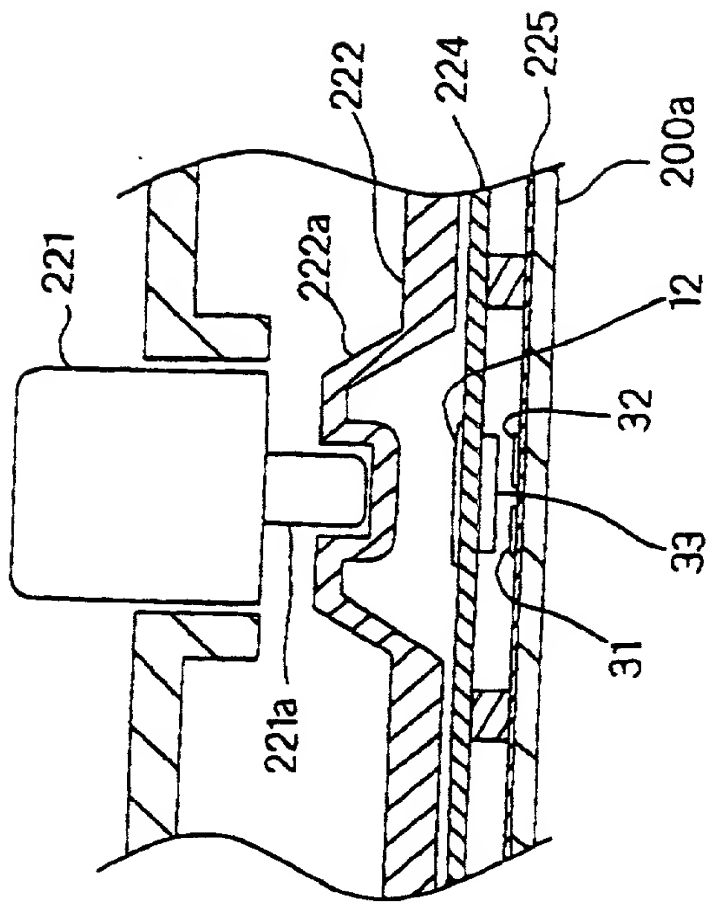


FIG. 33

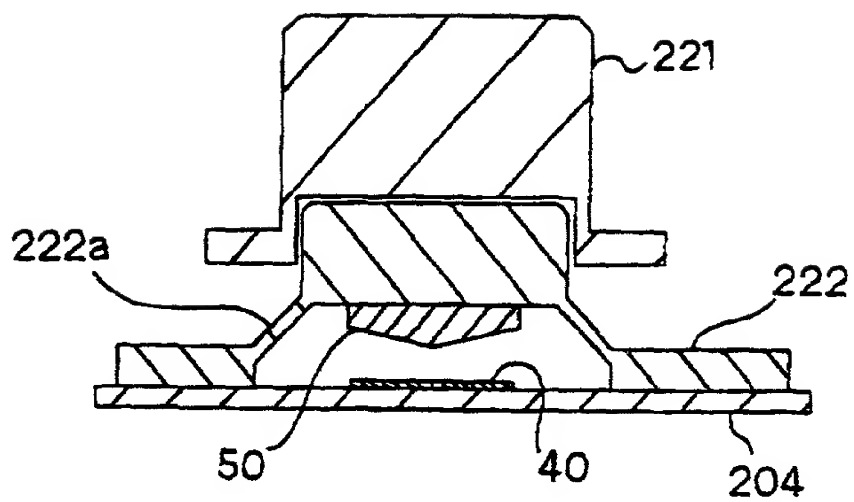


FIG. 34A

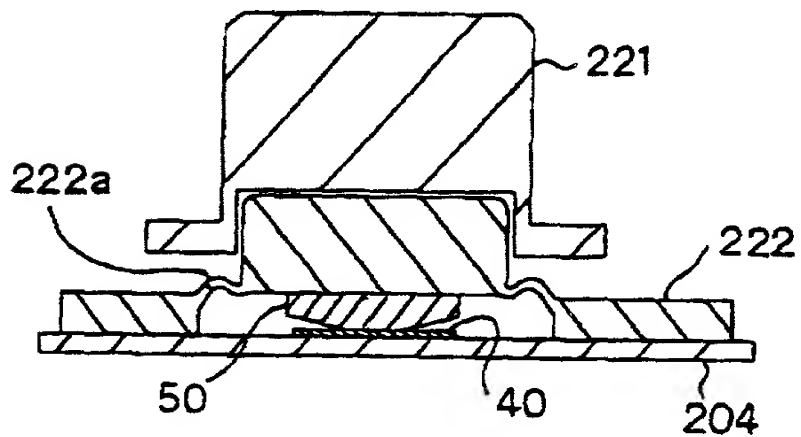


FIG. 34B

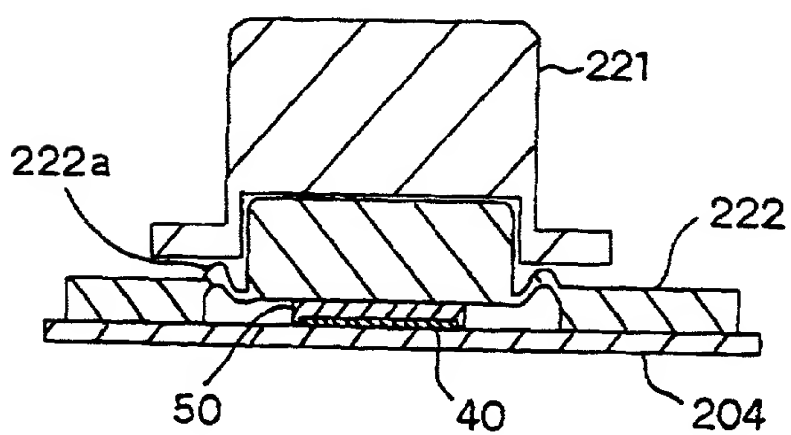


FIG. 34C

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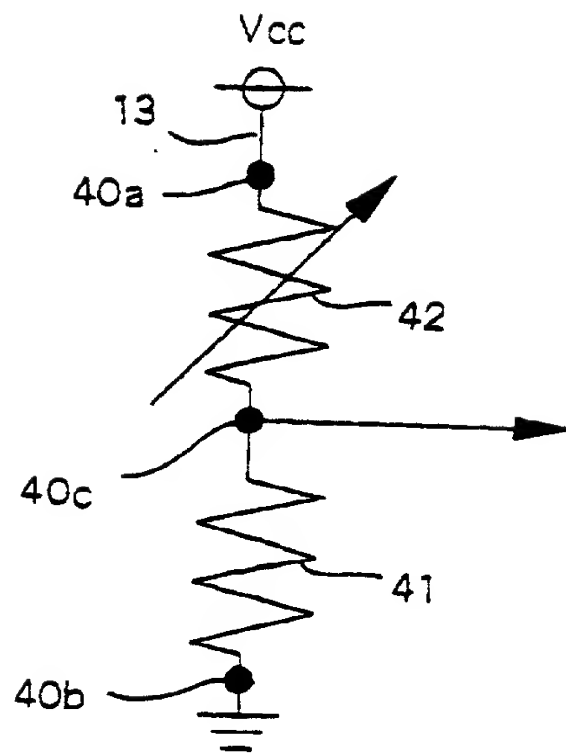


FIG. 35

Table 1. Demographic characteristics of the study population	
Age (years)	45.5 ± 10.5
Gender (male/female)	10/10
Education (years)	12.5 ± 1.5
Occupation (white/blue)	10/10
Marital status (married/divorced)	10/10
Smoking status (smoker/nonsmoker)	10/10
Alcohol consumption (yes/no)	10/10
Family size (number of children)	2.5 ± 1.5
Household income (USD/month)	1,200 ± 200
Health insurance (yes/no)	10/10
Comorbidities (hypertension/diabetes)	5/5
Medication use (yes/no)	10/10
Stress level (high/low)	10/10
Social support (strong/weak)	10/10
Life satisfaction (high/low)	10/10
Overall health status (good/poor)	10/10

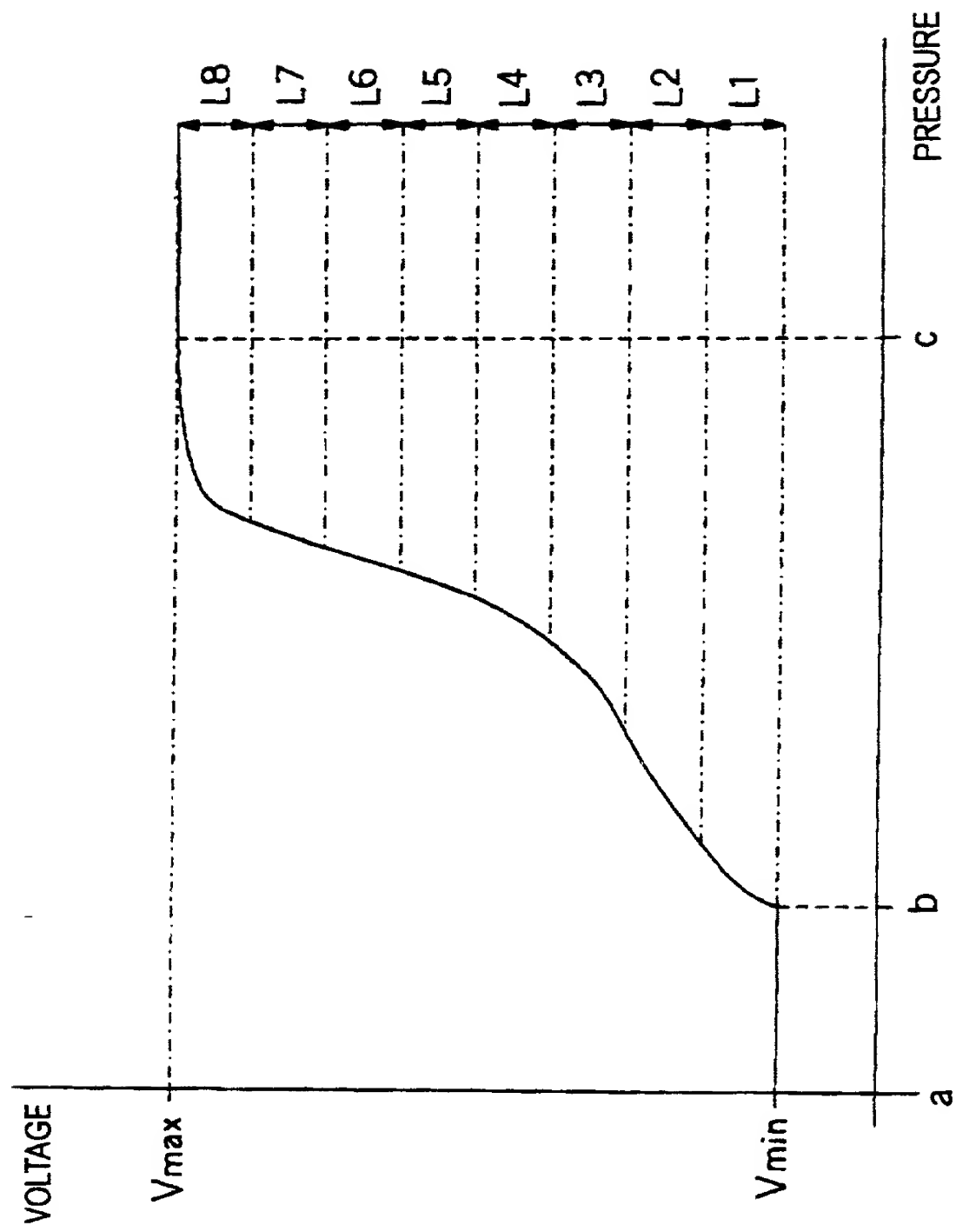


FIG. 36



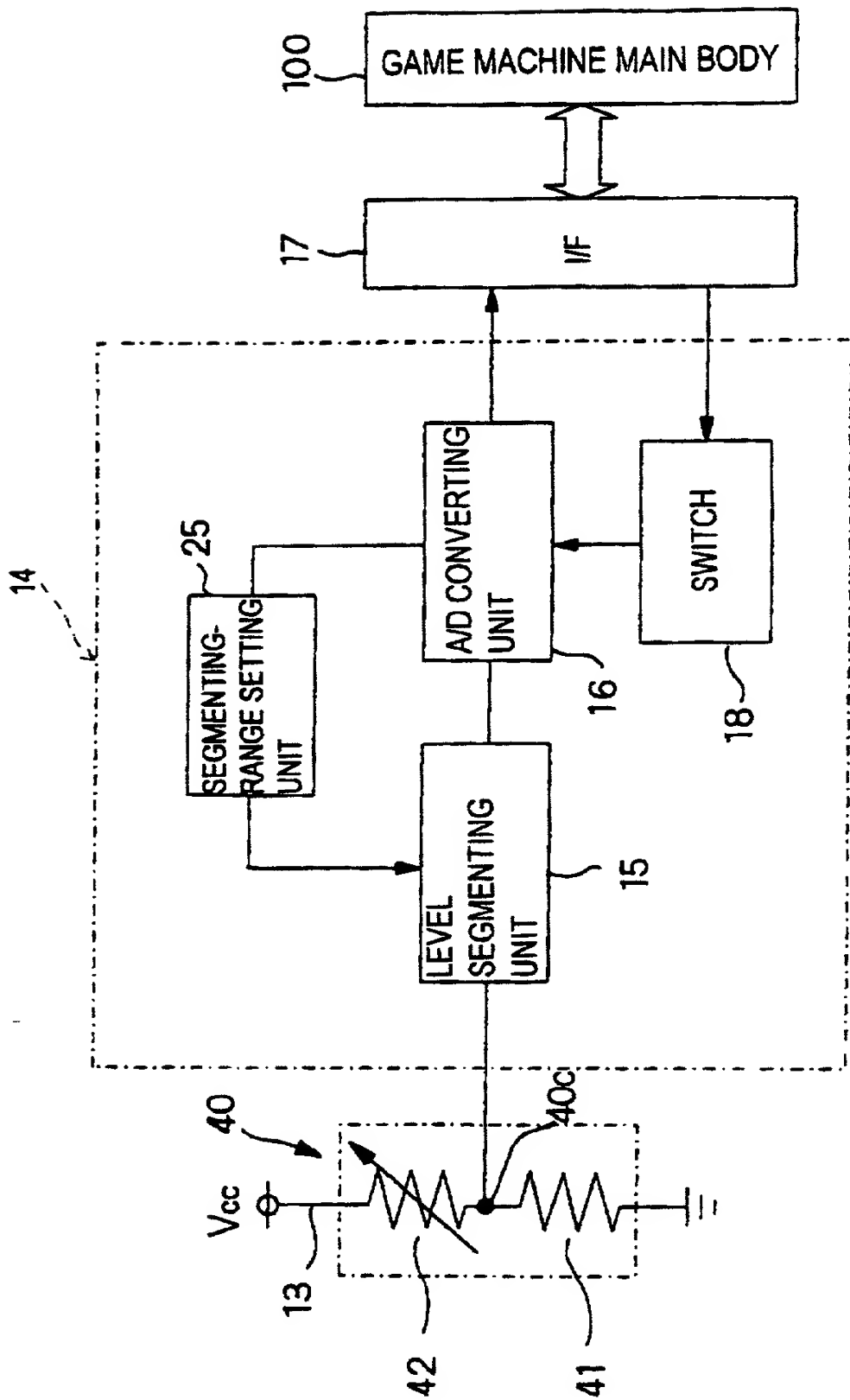


FIG. 37



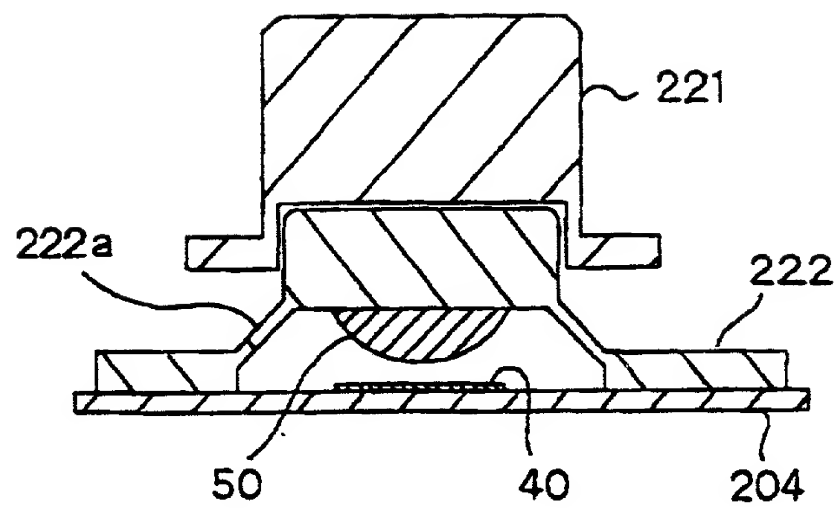


FIG. 39A

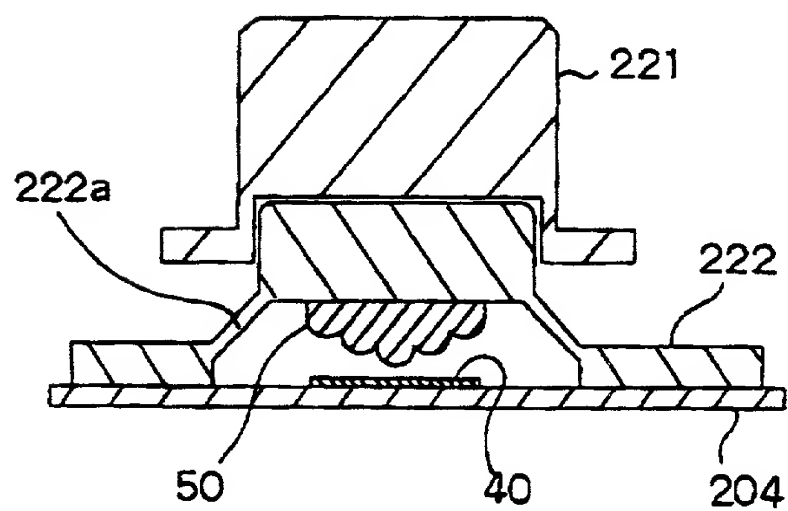


FIG. 39B

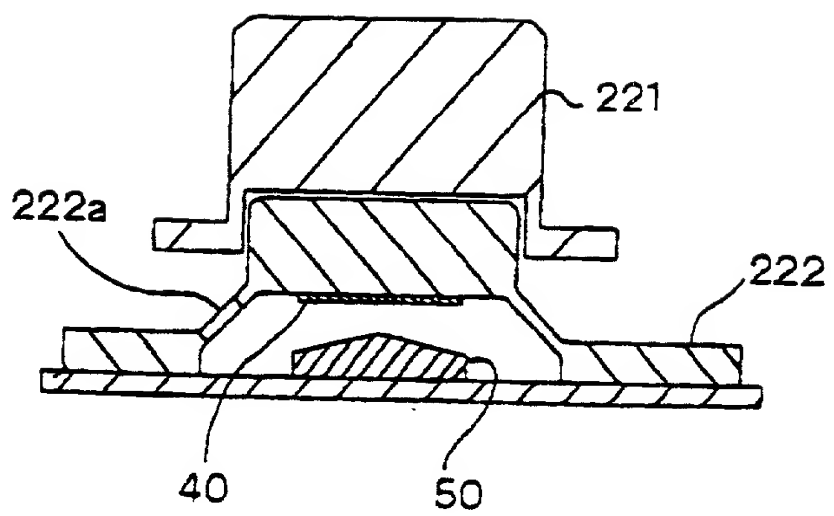


FIG. 40

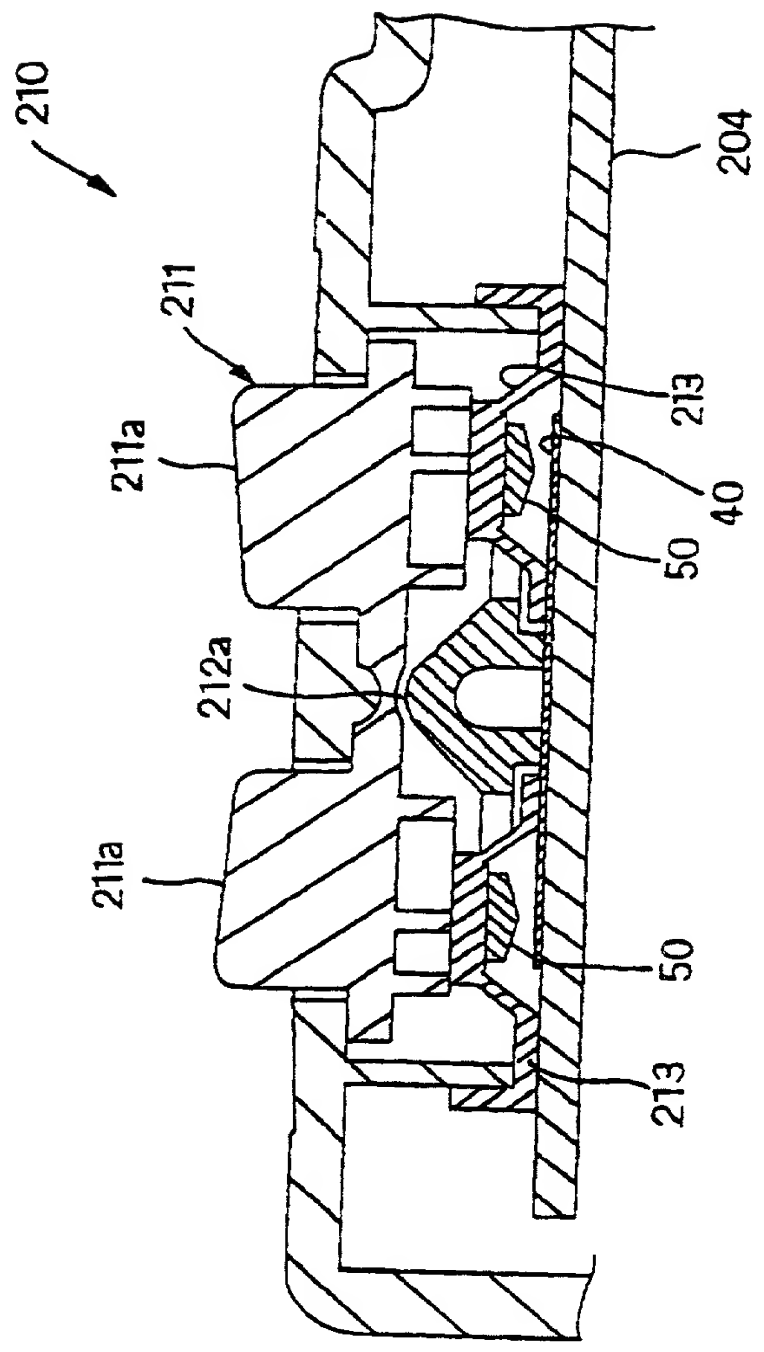


FIG. 41

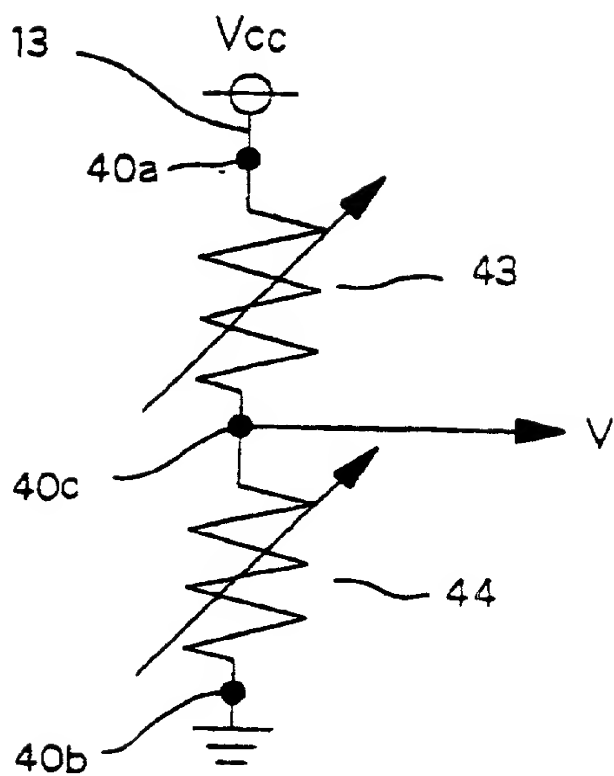


FIG. 42



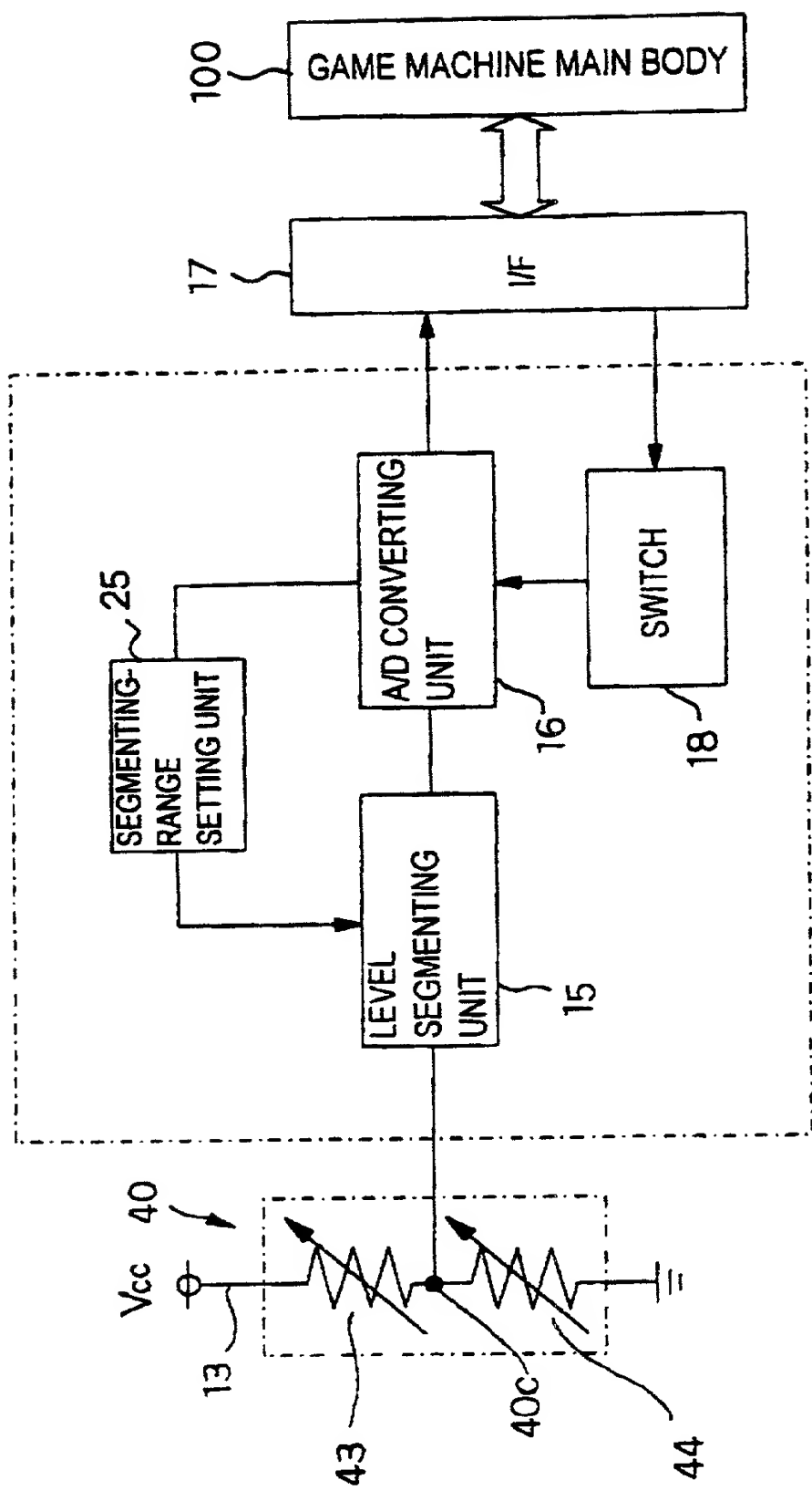


FIG. 44





## Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

### Japanese Language Declaration

#### 日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

CONTROL APPARATUS AND OUTPUTTING

SIGNAL ADJUSTING METHOD THEREFOR

上記発明の明細書（下記の欄でx印がついていない場合は、本書に添付）は、

the specification of which is attached hereto unless the following box is checked:

☐ 月 日に提出され、米国出願番号または特許協定条約国際出願番号を \_\_\_\_\_ とし、  
（該当する場合） \_\_\_\_\_ に訂正されました。

☐ was filed on \_\_\_\_\_  
as United States Application Number or  
PCT International Application Number  
\_\_\_\_\_ and was amended on  
\_\_\_\_\_ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されたとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

## Japanese Language Declaration (日本語宣言書)

私は、米国法典第35編119条(a)-(d)項又は365条(b)項に基づき下記の、米国以外の国の少なくとも一カ国を指定している特許協力条約365(a)項に基づき国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

### Prior Foreign Application(s)

外国での先行出願 Patent Application No. 11-297205	Japan
(Number) (番号)	(Country) (国名)
(Number) (番号)	(Country) (国名)

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

### Priority Not Claimed

優先権主張なし

September 11, 1999
(Day/Month/Year Filed) (出願年月日)
(Day/Month/Year Filed) (出願年月日)

私は、第35編米国法典119条(e)項に基づいて下記の米国特許出願規定に記載された権利をここに主張いたします。

(Application No ) (出願番号)	(Filing Date) (出願日)
-----------------------------	------------------------

私は、下記の米国法典第35編120条に基づいて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約365条(c)に基づき権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第35編112条第1項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日以降で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第37編1条56項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

(Application No ) (出願番号)	(Filing Date) (出願日)
(Application No ) (出願番号)	(Filing Date) (出願日)

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I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

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I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application.

(Status: Patented, Pending, Abandoned) (現況: 特許許可済、係属中、放棄済)
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(Status: Patented, Pending, Abandoned) (現況: 特許許可済、係属中、放棄済)
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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## Japanese Language Declaration (日本語宣言書)

委任状： 私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。（弁理士、または代理人の氏名及び登録番号を明記のこと）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number)  
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**Declaration and Power of Attorney For Patent Application -- Additional Prior Foreign Applications**

<u>Number</u>	<u>Country</u>	<u>(Day/Month/Year Filed)</u>	<u>Priority Not Claimed</u>
	<u>Japan</u>		<input type="checkbox"/>
	<u>Japan</u>		<input type="checkbox"/>

**Declaration and Power of Attorney For Patent Application -- Additional Inventors**

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